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Pertussis and Tdap Vaccine Effectiveness

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Periodic outbreaks of pertussis (whooping cough) occur in Washington and nationwide. Pertussis is cyclical with peaks every 3 to 5 years as the number of susceptible persons in the population increases due to waning of immunity following either vaccination or disease. A recently published study in Washington State adolescents aged 11-19 years demonstrated diminished vaccine effectiveness over time following Tdap vaccination.

Pertussis Vaccination



Bordetella pertussis bacteria are transmitted person-to-person through droplets from the nose and throat. Severe coughing spells are the hallmark of pertussis, and are often severe in infants. Deaths from pertussis are rare but do occur. Fifteen pertussis deaths were reported in Washington between 1982 and the present, most in very young infants.

DTP, the first licensed pertussis vaccine in the United States, was prepared from inactivated but whole-cell *B. pertussis* along with diphtheria and tetanus components. More recently developed acellular pertussis vaccines contain purified, inactivated components of *B. pertussis* cells and have fewer side effects than DTP vaccine. In 1991, acellular pertussis vaccines were licensed for use in the 4th and 5th doses of the childhood series. In 1997, DTaP completely replaced DTP in Washington State for all doses of the childhood series. Another acellular vaccine, Tdap, was licensed in 2005 for use in adolescents and adults.

The current pertussis immunization schedule recommends DTaP at 2, 4, and 6 months, with a fourth dose at 15-18 months and a fifth at 4-6 years. A booster dose of Tdap is routinely given at 11-12 years of age. For most

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people, Tdap vaccine is recommended only once. However, in October 2012, the Advisory Committee on Immunization Practices (ACIP) voted to recommend Tdap during every pregnancy to protect infants because they have the greatest risk for severe or fatal pertussis.

Pertussis in Washington

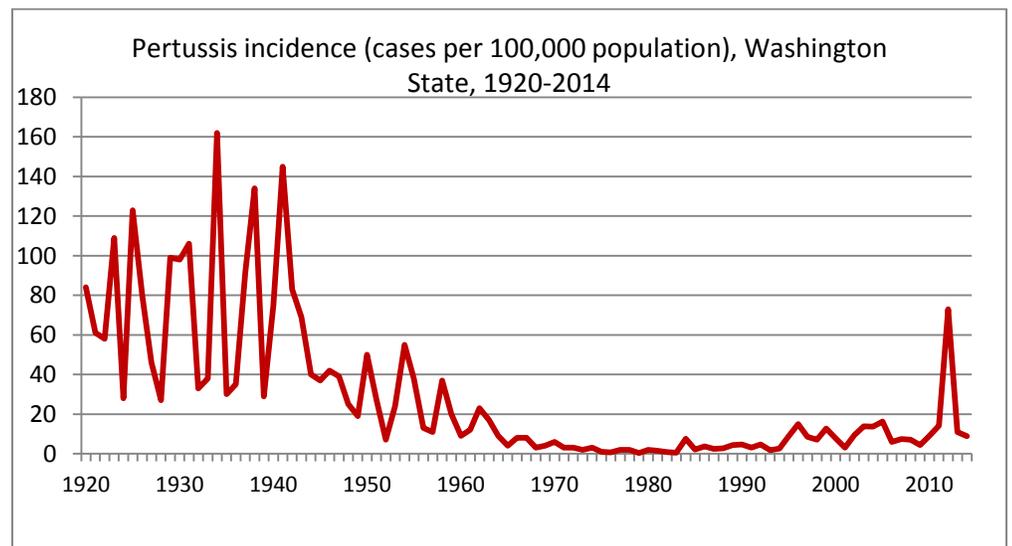
Pertussis surveillance in Washington started in 1920 during the pre-vaccine era. That year there were 104 deaths among the 2,062 reported cases, a case fatality rate of 5%. The highest annual pertussis incidence was 162 cases/100,000 population in 1934. The introduction in 1949 of DTP vaccine greatly reduced pertussis rates. By the late 1970s, only about 1,000 cases per year were reported nationwide with few deaths. However, controlling this highly contagious disease has remained challenging, and pertussis rates have been on the rise again during the past two decades.

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A statewide epidemic occurred in Washington during 2012 with nearly 5,000 reported cases and an annual incidence of 73 cases/100,000 population; there were no deaths. School-aged children (5-18 years) represented 57% of cases. Incidence by age group was highest in infants (428 cases per 100,000) but was also unexpectedly elevated in 13- and 14-year-olds (342 and 336 cases per 100,000, respectively). Nearly 80% of the adolescent cases were up-to-date for the Tdap booster vaccine recommended at 11-12 years of age. This emerging trend, also seen nationwide, led to concerns about the effectiveness and duration of protection of the acellular pertussis vaccines. In response, Washington State Department of Health (DOH), in collaboration with the Centers for Disease Control and Prevention (CDC), conducted an evaluation of Tdap vaccine effectiveness and duration of protection in adolescents.

Tdap Vaccine Effectiveness Study

Public health researchers from DOH and CDC recently published data from a case-control study that examined Tdap vaccine effectiveness and duration of protection in adolescents during Washington's 2012 pertussis outbreak. Vaccine histories of adolescents born from 1993 through 2000 (11-19 years of age) were collected for cases (adolescents with pertussis) and three matched controls (adolescents without pertussis) for each case. Case-control groups were then stratified by age: those born from 1998-2000, who would have only received acellular pertussis vaccine; and those born from 1993-1997, who would have received a mix of whole-cell and acellular pertussis vaccine. Vaccine effectiveness (VE) was computed as $(1 - \text{odds ratio}) \times 100\%$.



In this study, 84% of cases and 90% of controls had been vaccinated with Tdap at the recommended age of 11-12 years. Among adolescents born from 1998-2000 (received only acellular vaccine), overall VE was 64%. Effectiveness decreased with duration of time since Tdap vaccination: VE was 73% for a post-vaccination time of less than 12 months, 55% for 12-23 months, and 34% for 24-47 months. This waning immunity in adolescents who had received only the newer, acellular pertussis vaccine – only 34% VE by two to four years after Tdap vaccination – has likely contributed to recent increases in pertussis among adolescents.

Even though the level of immunity wanes over time, vaccination still offers the best available protection against pertussis. Previously vaccinated persons who get pertussis have less severe disease than persons never vaccinated, and are less likely to spread the disease to others, so there is continued need for vaccination among all age groups.

Finally, this study shows the importance of the 2012 ACIP recommendation to vaccinate women with Tdap during the third trimester (27-36 weeks gestation) of each pregnancy to both reduce the mother's risk of having pertussis and infecting her baby and also to allow antibodies to be passed to the fetus before birth which provides passive protection in the first few months of life, when the baby is most vulnerable and too young to be vaccinated. In addition, all persons who have contact with pregnant women and newborns should be up-to-date with pertussis vaccine.

Ongoing Challenges

Pertussis is on the rise again in Washington, with 513 cases reported in the first 18 weeks of 2015, compared to 111 during the same period last year. The majority of cases (72%) are among school-aged children and teens. A [weekly summary of pertussis activity](#) is available online. In response to the current rise in reported pertussis cases, a DOH workgroup was formed to coordinate pertussis response and information. In mid-April 2015, the State Epidemiologist sent a pertussis letter to health care providers along with "Pertussis: Key messages for health care providers." These documents were shared with state health care organizations and health care provider groups. DOH also issued a press release informing the public of the pertussis vaccine effectiveness study (See Resources).

Even though the current pertussis vaccines have limitations, up-to-date vaccination of children and of pregnant women remains the best way to reduce transmission of pertussis and to prevent cases among the most vulnerable children.

Resources

Acosta AM et al. Tdap vaccine effectiveness in adolescents during the 2012 Washington State pertussis epidemic. 2015. *Pediatrics* 135(6):1-9.

<http://pediatrics.aappublications.org/content/early/2015/04/28/peds.2014-3358.abstract>
(abstract only; full text may require subscription)

DOH news release: “Whooping cough study shows vaccine protection fades over time”

<http://www.doh.wa.gov/Newsroom/2015NewsReleases/15067WhoopingCoughVaccineStudy>

DOH webpage for pertussis (including weekly summary):

<http://www.doh.wa.gov/YouandYourFamily/IllnessandDisease/WhoopingCough>

Mid-April 2015 pertussis letter to health care providers from WA State Epidemiologist:

<http://www.doh.wa.gov/Portals/1/Documents/Pubs/PertussisLetterProviders2015.pdf>

DOH “Pertussis: Key messages for health care providers”:

<http://www.doh.wa.gov/Portals/1/Documents/Pubs/Pertussis-HCP-KeyMessages2015.pdf>

DOH public health guidelines for pertussis:

<http://www.doh.wa.gov/Portals/1/Documents/5100/420-066-Guideline-Pertussis.pdf>

CDC information about pertussis and pregnancy: www.cdc.gov/pertussis/pregnant