Pertussis: Descriptive Epidemiology Project

Professor Boye

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Pertussis, also known as whooping cough, is a highly contagious respiratory disease (CDC Pertussis, 2013) and global public health concern causing many infant deaths. The World Health Organization (WHO) suggests that in 2008 about 16 million cases of pertussis occurred throughout the world with 95 percent of those cases occurring in developing countries. Of these, about 195,000 children died from the disease and it continues to be a great concern in all countries even those with vaccine coverage (WHO, 2010). Currently, it is estimated that 50 million cases and 300,000 deaths occur every year from pertussis (WHO Immunization surveillance, assessment and monitoring, 2013).

Pertussis not only affects infants, but is a disease that can cause serious illness in both children and adults (CDC Pertussis, 2013). The Centers for Disease Control and Prevention (CDC) describes Pertussis as an endemic disease in the United States that peaks with frequent outbreaks every three to five years. As recently as 2010, there were 27,550 reported cases in various regions in the United States, with many going unreported (CDC Pertussis Outbreaks, 2013). In Washington State alone there were 2,520 reported cases in 2012. This number of cases can be explained as 37.5 cases per 100,000 residents. This is the highest number of cases reported in the U.S. since 1942. In the same year there were reported cases in 32 of 39 countries throughout the world (CDC MMWR, 2012).

Pertussis is caused by the bacterium Bordetella pertussis (B. pertussis) and causes violent coughing making it hard to breathe (CDC Pertussis, 2013). B. pertussis is a very small cocobacillus that may appear singly or in pairs. The bacteria are very particular nutritionally and
usually cultivate on “rich media supplemented with blood.” The organism usually grows slowly (even on a culture medium containing whole blood) requiring three to six days to form colonies. B. pertussis colonizes in the cilia of the epithelium lining of the respiratory tract. This bacteria is a pathogen for humans (possibly higher primates), but no other reservoir is known (Online Textbook of Bacteriology, 2012).

The disease has two stages, first colonization presenting as an upper respiratory disease with symptoms of fever malaise and coughing. This will increase during a ten-day period. During colonization, the organism can be recovered through pharyngeal cultures and the severity of the disease can be reduced by antimicrobial treatment. The second stage of colonization begins gradually with prolonged coughing and often ends in a characteristic “whoop” or gasp (Online Textbook of Bacteriology, 2012).

As a respiratory infection, when an infected person sneezes or coughs, tiny droplets containing the bacteria move through the air and the disease is spread from person to person. The infection generally lasts about six weeks (Medlineplus Pertussis, 2013). In the early stage, pertussis is highly communicable, with a secondary attack rate of up to 90 percent among household contacts. Those that go untreated may be contagious for three weeks or more following the onset of the typical coughing. Chronic carriers of pertussis are uncommon (WHO, 2010).

The disease usually will start with cold-like symptoms sometimes with a mild cough or fever. Severe coughing can begin after one to two weeks (CDC Pertussis, 2013) and in children often ends with a “whoop” noise; this sound occurs when the child tries to take a breath. The
sound is rare in children under six months of age and in adults. The severe coughing may lead to vomiting and possibly even a short loss of consciousness. Choking spells are common in infants. Other symptoms include runny nose, slight fever, and diarrhea (Medlineplus Pertussis, 2013). In infants the cough may be minimal or may not be present. Their symptoms may present as apnea or a pause in the child’s breathing pattern. Pertussis is very dangerous for infants, as approximately half of infants under a year of age who contract pertussis are hospitalized. The disease progression of pertussis is reflected in Figure 1 below (CDC Pertussis, 2013).

Figure 1. Disease Progression of Pertussis

The best way to protect against pertussis is immunization (CDC Pertussis, 2013). In the United States today, the pertussis vaccine is only administered through a combination shot called DtaP, or Tdap. These contain vaccines for diphtheria (D), tetanus (T), and pertussis (P). This vaccine is routinely given in the U.S. six times for each child. It is administered at ages two,
four, six, fifteen and eighteen months of age and again between four and six years of age. A Tdap booster is administered between twelve and thirteen years of age. In 1996, the U.S. replaced the older whole cell pertussis vaccine (DPT), created in 1912 although it was still available in some physician’s offices until 1999. Many other countries still use DPT (National Vaccine Information Center, 2013).

DPT contains whole B. pertussis bacteria that have been inactivated with heat and chemicals, as well as an aluminum adjuvant and mercury preservative. The purified DtaP/Tdap vaccines (packaged in single dose vials) contain reduced bioactive pertussis toxin, less endotoxin and either little or no mercury along with the aluminum adjuvant. Depending on the manufacturer, the vaccines generally contain a varying amount of inactivated pertussis toxin, filamentous hemagglutinin (FDA), pertacin, fimbriae, formaldehyde, polysorbate 80 (Tween 80), gluteraldehyde, 2-phenoxoyethanol, aluminum and thimersol (mercury) (National Vaccine Information Center, 2013). Although there is a widespread childhood vaccination program, pertussis still remains an endemic in the U.S. that peaks with frequent outbreaks every three to five years (CDC Pertussis Outbreaks, 2013). The CDC explains that there are difficulties with laboratory confirmation of B. pertussis thus contributing to an under-reporting of the disease (CDC Pertussis, 2013).

Before vaccines became widely available, pertussis was one of the most common childhood diseases worldwide. Following a large-scale vaccination during the 1950s and 1960s, there was a dramatic reduction by 90 percent in incidence and mortality of pertussis observed in the industrialized world. It is recorded that in 1974 and 2008 about 82 percent of all infants
worldwide received three doses of the pertussis vaccine with the World Health Organization (WHO) estimating that in 2008 the global vaccination against pertussis averted about 687,000 deaths (WHO 2010). However pertussis remains as a major cause of childhood morbidity and mortality, as there is evidence of a high incidence of pertussis in developing countries. Pertussis remains one of the world’s leading causes of vaccine-preventable deaths and as mentioned previously, it is estimated that 50 million cases and 300,000 deaths occur every year from pertussis. The case-fatality rates in developing countries are estimated to be as high as four percent in infants (WHO Immunization surveillance, assessment and monitoring, 2013).

Although little is known about the duration of the protection of the vaccine in developing countries, there have been several studies in the industrialized world to show that the protection from the vaccine wanes after four to twelve years of age and pertussis has increasingly been reported in older children, adolescents, and adults (WHO, 2010). Now that most children are immunized prior to starting school, there is a higher (not the highest) percentage of pertussis cases seen among adolescents and adults (Medlineplus, 2013). Consequently, adolescents and adults are a significant source for transmission to unvaccinated young infants (WHO, 2010). Pertussis is most fatal in infants and young children less than one year of age (CDC Pertussis, 2013). Severe disease and death have been reported mainly during the first weeks and months of life. In older children, adolescents, and adults pertussis often goes unrecognized (WHO, 2010).

Currently pertussis is a nationally-notifiable disease and cases should be reported to the appropriate health department. Pertussis cases are then reported by states to the CDC through the National Notifiable Diseases Surveillance System (NNDSS) to monitor for epidemiologic trends
(CDC Pertussis Surveillance and Reporting, 2013). Reflected in Figure 2 below is the pertussis incidence (per 100,000 persons) by age group in the United States from 1990-2012. The graph shows that infants who are less than one year of age continue to have the highest reported rate of pertussis. Although children between seven and ten years of age continue to contribute to a significant portion of reported pertussis cases, the 2012 data indicates that pertussis is increasing among adolescents between thirteen and fourteen years of age (CDC Pertussis Surveillance and Reporting, 2013). Additionally, the U.S. has been affected by pertussis very differently among the states. From 2011 – 2012, there have been clusters of states that have increased two-fold, between two and three fold, and three fold (CDC Pertussis Surveillance and Reporting, 2013). This is reflected in Figure 3 below.

**Figure 2. Reported Pertussis incidence in the United States by age group from 1990-2012.**

(CDC Pertussis Images, 2012)
As reflected above, the states that demonstrated a three-fold or greater increase from 2011 – 2012 include Washington, Oregon, Nevada, Montana, Wyoming, Colorado, New Mexico, North Dakota, Nebraska, Kansas, Minnesota, Iowa, Wisconsin, Kentucky, Tennessee, Maine, Vermont, North Carolina, Massachusetts, Delaware, and Maryland (CDC Pertussis Surveillance and Reporting, 2013).

As of January 10, 2013, there have been multiple states with an incidence of pertussis higher than the 2012 national incidence of 13.4/100,000 persons. The states (from highest to lowest) with an incidence rate higher or equal to the 1212 national incidence rate include Wisconsin (104.9), Vermont (100.6), Minnesota (82.9), Washington (67.4), North Dakota...
(54.4), Iowa (53.5), Maine (52.9), Utah (47.5), Montana (44.3), Alaska (43.3), New Mexico (35.7), Colorado (28.9), Kansas (25.5), Oregon (23.3), New Hampshire (16.4), New York (15.8), Pennsylvania (14.5), Illinois (14.5), Idaho (14.3), Missouri (14.2) and Arizona (13.4) (CDC Pertussis Surveillance and Reporting, 2013). These are reflected in Figure 4 below.

**Figure 4. U.S. States equal to or exceeding the National Pertussis Incidence Rate for 2012.**

(CDC Pertussis Surveillance and Reporting, 2013).

Pertussis affects females more commonly than males, although there has been no identified reason for this occurrence (Southern Cross Healthcare, 2013). In the U.S., it has also been reported to affect persons who are white/Caucasian significantly more (90 percent of reported cases) than those of other races (CDC MMWR, 2005). Internationally it is estimated that there are between 30 and 50 million pertussis cases with about 300,000 deaths per year (CDC Pertussis in Other Countries, 2012). According to most recent data available, the countries with the highest number of recorded deaths resulting from pertussis are located in the western
hemisphere with the top three in South America. The country ranking the highest was Venezuela. Brazil came in second and Colombia third. The United States was ranked fourth just above Mexico (Nationmaster.com, 2013).

Socio-economic factors also seem to play a role in pertussis as it has been found that those with a higher socio-economic status have a higher rate of full vaccination and private vaccination for children less than five years of age (Topuzoglu et al., 2005). However there continues to be a myth associated with the DTaP vaccine that continues to prevent those with access to the vaccine from having it administered to their children. The myth is that DTaP causes sudden infant death syndrome. According to the CDC, this belief “came about” due to the “moderate proportion of children who die of SIDS” having recently been vaccinated with DTaP. The CDC explains that although there may appear to be a casual connection because three DTaP shots are administered when most SIDS deaths occur, that it is explained as occurring “simply by chance.” They further explain that several well-controlled studies found that the number of SIDS deaths would have occurred even if no vaccinations had been given (CDC Some Common Misconceptions, 2011).

Suggested areas for further research are with regards to teenagers and adults and how the vaccine may be administered so that the efficacy is prolonged. This may include modifying the current vaccine or making modifications to the vaccine schedule allowing for more boosters to become available for the vaccine. Another recommendation is to expand current vaccination campaigns beyond expecting parents and healthcare workers. The campaign should be designed
to reach grandparents, aunts, uncles, cousins, and anyone who may come into close contact with
infants and young children.
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