**Pertussis:**
“Whooping Cough”

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**Disease Etiology:**

Pertussis is caused by the bacteria *Bordetella pertussis* and *Bordetella parapertussis*, the latter often resulting in milder symptoms due to the non-expression of the pertussis toxin (2). Pertussis is also known as whooping cough due to the characteristic inspiratory “whooping” sound commonly made by infected children after coughing. It is a highly contagious bacterial infection of the upper respiratory system that causes violent and uncontrollable coughing (1).

**Transmission:**

Pertussis is mostly spread through inhalation of infectious airborne droplets produced by coughing or sneezing. Direct or indirect physical contact with respiratory secretions can also result in infection (3). Pertussis is contagious and is easily spread when in close or prolonged contact with an infected person. Studies have found that the average attack rate for unvaccinated children with an infected person in the household is 76% (range, 64%-86%). Attack rates in the classroom are lower ranging from 0%-36% (4). The pertussis incubation period is 1-2 weeks, followed by the catarrhal phase, where coughing begins. A person remains contagious up to 5 weeks after coughing episodes begin. A person only remains contagious for 5-10 days after antibiotic treatment begins (2).

**Reservoirs:**

Humans are the only reservoir of *B. pertussis*, and *B. parapertussis*. Adults and adolescents with undiagnosed pertussis infections often spread the infection to others including young children (3).

**Microbial Characteristics:**

*Bordetella pertussis* and *Bordetella parapertussis* are small (approximately 0.8 μm by 0.4 μm) non-motile bacteria (2). *B. pertussis* and *B. parapertussis* are cocccobacillus in shape, and are strict aerobes. They are fastidious, requiring rich media supplemented with blood to grow (5). *B. pertussis* and *B. parapertussis* are encapsulated and do not produce spores (2).

*B. pertussis* adheres to the cilia in the mucosa of the respiratory tract using fimbriae and produces a number of harmful toxins (2).

*Bordetella brochiseptica* is another species in the *Bordetella* genus. *B. bronchiseptica* mainly affects animals including dogs, cats, and sheep. *B. bronchiseptica* can also infect humans (2). *B. avium* and *B. hinzii* infect poultry, and rarely infect humans. The species mentioned above have similar morphology, size, and staining to *B. pertussis* (2).
Identification Tests:

Bacterial cultures, polymerase chain reaction assays (PCR), and serology are the three types of tests routinely used to diagnose *B. pertussis* (6). The tests vary in their testing time, specificity, and optimal collection time.

Culture is considered the “gold standard” for diagnosing pertussis because it is 100% specific (6). However, cultures take 7-10 days to confirm after a nasopharyngeal (NP) is obtained, and the risk of a false-negative test increases if the sample is obtained >2 weeks after coughing has begun (7).

PCR assays are a rapid diagnostic test often used in conjunction with cultures and serology. PCR can be done up to 4 week after coughing has begun. PCR is highly specific (86%-100%) and highly sensitive (70%-90%) (7). The high sensitivity of PCR tests makes a false-positive test more likely.

Serology is a useful testing method often used in the later stages of pertussis infection. The optimal collection time is 4-8 weeks after coughing begins, but can be performed as early as 2 weeks post-cough, and as late as 12 weeks post-cough (6)(7).

Signs and Symptoms:

Pertussis infection progresses in 3 stages:

- **Stage 1:** The catarrhal stage lasts 1-2 weeks after infection and patients often exhibit cold-like symptoms, which include: low-grade fever and runny nose, patients may have a mild cough and infants may experience apnea (8).
- **Stage 2:** The paroxysmal stage lasts from 1-6 weeks, up to 10 weeks, and symptoms include: fits of numerous, rapid coughs often followed by inspiratory “whoop”, vomiting and exhaustion after coughing (8).
- **Stage 3:** The convalescent or recovery stage lasts 2-3 weeks. Coughing lessens as times passes, but the patient is susceptible to other respiratory infections (8).

![Disease Progression:](image)

-CDC (8)
**Historical Information:**

Pertussis was first described during the Middle Ages, and the first epidemic is thought to have taken place in Paris in 1578 (9). Jules Bordet and Octave Gengou isolated *B. pertussis* for the first time in 1906 (9). In the 20th century pertussis was one of the most common childhood diseases and a leading cause of childhood mortality (10). Prior to a vaccine being available, there were more than 200,000 cases of pertussis infections annually in the U.S. alone (10). Pertussis incidence has decreased by more than 80% since vaccination has become widespread, but pertussis is still a major cause of childhood death in many developing countries (10).

**Virulence Factors:**

*Bordetella pertussis* and *Bordetella parapertussis* contain numerous antigens and toxins that make the bacteria very harmful. The toxins and antigens of *B. pertussis* paralyze and kill cilia, cause inflammation, and allow the bacteria to evade host defenses and even invade tissues, such as the alveolar macrophages (10). *B. parapertussis* contains the genes for the exotoxin known as the pertussis toxin (PTx), but does not express them (2). The pertussis toxin expressed by *B. pertussis* is particularly virulent and can decrease the phagocytic function of phagocytes, cause lymphocytosis, and increase insulin and histamine production resulting in hypoglycemia, increased capillary permeability, hypotension, and shock (11)(12). Filamentous hemagglutinin (FHA) is a fimbrial-like structure on the surface of *B. pertussis*, which plays a large role in adhesion to the cilia (11). Other toxins produced by *B. pertussis* include adenylate cyclase toxin, tracheal cytotoxin, pertactin, and dermonecrotic toxin (12). Adenylate cyclase toxin (*CyaA*) helps *B. pertussis* invade host defense by decreasing phagocytic activity, and causes hemolysis (11)(12). Tracheal cytotoxin (*TCT*) paralyzes and kills ciliated epithelial cells and stimulates the release of interleukin-1, which causes fever (11)(12). Pertactin is an outer membrane protein that helps *B. pertussis* adhere to cilia (12). Dermonecrotic toxin (*DNT*) is a lethal toxin that induces inflammation, vasoconstriction, and necrosis at sites near *B. pertussis* (11)(12).

**Control/Treatment:**

Treatment for pertussis includes mainly supportive care with fluids and antipyretics, and the use of antibiotics such as tetracycline, erythromycin, and chloramphenicol, erythromycin being the drug of choice (2)(10). If pertussis is suspected, the child or adult should be isolated as much as possible during the first 4 weeks of illness (2). Unimmunized children who have been exposed may be given erythromycin for 10 days, and immunized children 4 years and younger may receive a booster vaccine (2). A person remains contagious for 5-10 days after antibiotics are given (2).

*B. pertussis* is sensitive to a variety of disinfectants such as glutaraldehyde, low concentrations of chlorine, 70% ethanol, phenolics, paracetic acid, and moist and dry heat (3). *B. pertussis* can survive for 3-5 days on inanimate dry surfaces, 5 days on clothes, 2 days on paper, and 6 days on glass (3).
**Prevention/Vaccination:**

Prevention of pertussis is mainly achieved through vaccination. The CDC recommends children receive 5 doses of the Diphtheria Tetanus acellular Pertussis (DTaP) vaccine at 2 months, 4 months, 6 months, 15-18 months, and 4-6 years of age (13). The DTaP shot contains purified diphtheria, tetanus, and pertussis toxoids (10). The pertussis toxoids often include detoxified PT, FHA, pertactin, and fimbriae (10). A Tdap vaccine is recommended for children at 11 years old, and as a booster every 10 years. The Tdap vaccine is also recommended for healthcare professionals, especially ones who work with children younger than 12 months (10). The lowercase “d” and “p” indicate a lower concentration of toxoids in the vaccine (10).

A whole-cell inactivated *B. pertussis* vaccine was developed in the 1940’s and achieved a 70%-90% efficacy rate after 3 doses (10). However, due to endotoxins present in the lipopolysaccharide membrane, the DwPT vaccine caused concerning adverse reactions and is no longer used in the United States (10).

The DTaP and Tdap vaccine currently in use in the United States and in many countries has an efficacy rate of 80%-85% (10).

**Current Outbreaks/Local Cases:**

The Texas Department of State Health Services (TDSHS) reported 3,908 cases of pertussis in 2013. The incidence rate was 14.5 per 100,000 people. There were 5 deaths, and 11.4% of cases required hospitalization. Children <1 year old accounted for 22.6% of cases, and children under 11 made up about 64% of cases (14). TDSHS says that pertussis cases occur in waves with peaks every 3-5 years. There were outbreaks in 2005 and 2008, and there appears to be an on going outbreak that began in 2012 (15). The number of cases in 2012 was 2,218; more than double the number in 2011, which was 961 (15).

Nationally, there were 48,277 cases of pertussis in the United States in 2012. This is significantly higher than the 18,719 cases reported in 2011 (16). There were 20 deaths in the U.S. in 2012 attributed to pertussis, with 15 deaths occurring in infants less than 3 months old (16).

**Current Outbreaks/Global Cases:**

The World Health Organization estimates that in 2008 there were 16 million cases of pertussis and about 195,000 deaths due to pertussis, with 95% of cases occurring in developing countries (17).