Pertussis

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Abstract

Pertussis is an infectious disease of the respiratory tract caused by the Gram-negative bacterium *Bordetella pertussis*. Pertussis vaccines have led to a significant reduction in the incidence and severity of pertussis in infants worldwide. Despite this decrease in incidence, pertussis remains one of the principal causes of vaccine-preventable deaths; in 2008, the World Health Organization reported an estimated 16 million cases per year and 195,000 paediatric deaths. Pertussis infection can occur at any age. In the last 20 years, there has been an increase in the number of adolescent and adult cases reported in high-income countries with good vaccination coverage. These cases represent a potential source of infection to unimmunized infants, who typically have a more severe course with higher mortality. Pertussis infection in previously immunized adults, the elderly or young infants frequently presents with atypical symptoms and can easily be overlooked as a diagnosis. This review provides a summary of *B. pertussis* and discusses diagnostic tests, treatment and prevention.

Keywords Aetiology; antibiotics; *Bordetella pertussis*; clinical features; diagnosis; epidemiology; MRCP; pathogenesis; transmission; vaccination

Key points

- Vaccination has reduced the incidence of pertussis globally, but in recent years there has been an increase in cases in adolescents and adults that represents a source of infection to unimmunized infants
- In young infants and those who have previously been vaccinated, presenting features can be atypical
- When pertussis is suspected, antibiotics should be given (if disease onset was within 21 days), the health protection team should be informed, and details of household contacts should be ascertained to decide if chemoprophylaxis is required
- Vaccination in pregnancy has been shown to reduce the incidence of pertussis disease in infants and is being employed in more countries worldwide

Aetiology

Pertussis is an infectious disease of the respiratory tract caused by *Bordetella pertussis* or, less commonly, *Bordetella parapertussis*. *Bordetella* spp. are strictly aerobic, Gram-negative coccobacilli.

Epidemiology

In the pre-vaccine era, pertussis was an endemic disease with epidemic peaks occurring approximately every 3 years. Most cases occurred in young children, and mortality was high.

The introduction of pertussis vaccines in the 1940s led to a significant reduction in pertussis globally. In 2015, the World Health Organization (WHO) estimated that 86% of infants worldwide were given three doses of pertussis vaccine in the first year of life (as part of the diphtheria–tetanus–pertussis combination). Although the incidence of pertussis has decreased, the 3-year epidemic cycle continues in many countries, and pertussis remains one of the principal causes of vaccine-preventable deaths; in 2008, the WHO reported an estimated 16 million cases per year and 195,000 paediatric deaths.[1] In the last 20 years, there has been an increase in the number of adolescent and adult cases reported in North America, Australia and Europe, including the UK. These cases represent a potential source of infection to unimmunized infants, who typically have a more severe course with higher mortality.

Pathogenesis

The disease process in pertussis is multifactorial and dependent on several *B. pertussis* virulence factors. The principal factors are those that have been included in the new acellular pertussis vaccines – pertussis toxin, filamentous haemagglutinin, pertactin and agglutinogens. Other factors (e.g. tracheal cytotoxin, adenylate cyclase toxin) may also be implicated. These factors, singly or in combination, enable the organism to attach to and damage the respiratory epithelium, avoid local immune mechanisms and elaborate toxins that cause the systemic effects of pertussis.

Transmission

B. pertussis is a human-specific pathogen that is unable to survive outside its host. Transmission is by aerosolized droplets. Pertussis is highly infectious, with a basic reproductive rate (i.e. the number of expected secondary transmissions from a single case of disease) of 15–17, and a secondary attack rate for household contacts of 80–100%, even in mild disease. The incubation period is typically 7–10 days, with untreated cases remaining infectious for 3 weeks following symptom onset. Antibiotics can limit this period of infectivity to 5 days. There is no

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evidence for a prolonged carrier state, although asymptomatic individuals have been identified during epidemics.

Clinical features

Typical

The three stages of pertussis are as follows.

Catarrhal: non-specific symptoms include rhinorrhoea, sore throat and non-productive cough. This stage typically lasts 2 weeks. Fever is present in <20% of cases.

Spasmodic: the cough becomes paroxysmal, and episodes of coughing can cause cyanosis or facial discolouration as a result of venous congestion. Episodes typically end with a deep inspiration (whoop) and vomiting. Paroxysms can occur >30 times per 24 hours and are more common at night. They occur spontaneously or are caused by external stimuli such as noise and cold air. Between coughing episodes, there are few clinical signs unless complications develop. This stage also typically lasts 2 weeks.

Convalescent: the coughing gradually subsides. Relapse can occur if another respiratory infection is acquired. This stage can last from 2 weeks to several months.

Atypical

Atypical features (Table 1) are common, especially in young infants and previously immunized adults. Pertussis may be responsible for between 12% and 32% of chronic cough in adults.[2]

Diagnosis

The diagnosis of pertussis is largely clinical. Confirmation or corroborative evidence can be gained from a history of contact with an infected person and/or laboratory investigations.

Atypical features of pertussis

Infants

- Apnoea
- Cough (no whoop)
- Cyanotic episodes
- Vomiting
- Poor feeding
- Fever
- Seizures
- Sudden infant death syndrome

Partially immunized

- Duration of catarrhal phase may be reduced
- Whoop may not occur

Adults

- Prolonged cough
- Paroxysmal cough
- Whoop
- Phlegm
- Post-tussive vomiting
- Intracranial haemorrhage

Table 1

Culture of secretions is highly specific but poorly sensitive. Sensitivity decreases with illness duration, antibiotic therapy, increasing age of the patient and, in children, prior vaccination against pertussis. Culture is unlikely to be positive in adolescents and adults after 3 weeks of symptoms, and serology is recommended in this case. Secretions are collected via a pernasal swab (posterior nasopharynx) or nasopharyngeal aspiration. *B. pertussis* is fastidious, requiring a special culture medium; growth occurs over 3–7 days.

Polymerase chain reaction (PCR) analysis is more sensitive than culture and is specific. However, PCR is less likely to be positive in patients who have had symptoms for <3 weeks. Nasopharyngeal swabs, aspirates and throat swabs are acceptable.

Serology is most useful in patients presenting in the convalescent phase of the illness when culture and PCR is rarely positive. Pertussis toxin immunoglobulin G can be measured by enzyme-linked immunosorbent assay methods. This is useful for diagnosis, but cannot be used to determine immune status. Young infants (<3 months) may not develop measurable antibodies, and false-positive results are seen after recent vaccination (within 1 year).

Full blood count frequently shows lymphocytosis, but this finding is non-specific.

Management

Supportive

Oxygen therapy and gentle suction of pharyngeal secretions are sometimes required during paroxysms. Specific treatments for the cough, including corticosteroids, salbutamol, montelukast, diphenhydramine and pertussis-specific immunoglobulin have been proposed, but a Cochrane review indicated that there was insufficient evidence at present to justify their use.[3]

Medication

Antibiotics have not been shown to influence the clinical course once the disease has commenced. However, they should be given within 21 days of symptom onset to eliminate the organism and prevent continuing transmission. Macrolide antibiotics are the treatment of choice, with co-trimoxazole reserved for patients in whom a macrolide is contraindicated. Azithromycin and clarithromycin are preferred to erythromycin in nearly all situations because of their more convenient dosing schedule, improved adverse effect profile and good *in vitro* activity against the organism (Table 2).

Pertussis is a notifiable disease and suspected cases should be notified to the local health protection team as soon as possible.

Prevention

Routine infant vaccination with whole-cell or acellular pertussis vaccines is the mainstay of pertussis prevention. Acellular pertussis vaccines are generally preferred to whole-cell vaccines because of their improved adverse effect profile.

In the UK, guidance from Public Health England recommends post-exposure prophylaxis with macrolide antibiotics for individuals who have not been given a pertussis vaccination within the last 5 years **and** who have had close contact with an infected person within 21 days, **and** who are themselves:

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