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Pertussis

Overview^{1, 2, 3, 4, 5}

Pertussis is a highly communicable, vaccine-preventable disease that affects the respiratory tract. The illness is caused by *Bordetella pertussis* (*B. pertussis*) bacteria, for which humans are the only known natural reservoir. In classic cases, pertussis begins with a runny nose, mild cough, and low-grade fever (the catarrhal stage), which progresses to paroxysmal spasms of severe coughing, inspirational “whooping”, and post-tussive vomiting. The duration of cough for classic pertussis is 6 to 10 weeks. Approximately half of adolescents with pertussis cough for 10 weeks or longer.¹ Pertussis has been called the “the 100-day cough”.² Pertussis may also present as a mild to moderate cough illness in people who are partially immune, which makes diagnosis more elusive to clinicians and can result in unrecognized cases.³ Pertussis is primarily a toxin-mediated disease. The bacteria attach to the cilia of the respiratory epithelial cells, produce toxins that paralyze the cilia, and cause inflammation of the respiratory tract, which interferes with the clearing of pulmonary secretions. Pertussis antigens appear to allow the organism to evade host defenses, in that lymphocytosis is promoted but chemotaxis is impaired. Until recently it was thought that *B. pertussis* did not invade the tissues. However, recent studies have shown the bacteria to be present in alveolar macrophages.⁵

Bordetella parapertussis which causes less severe pertussis-like illness accounts for 5% of isolates of *Bordetella* spp. in the USA. *Bordetella holmesii* (*B. holmesii*) is being increasingly recognized as a cause of pertussis-like illness worldwide. In 2010-2011, *B. holmesii* caused large community outbreak of pertussis-like illness in Ohio.

In the U.S., most hospitalizations and nearly all deaths from pertussis occur in infants under six months of age. In 2002-2011, four infants died in Missouri from pertussis. Complications are most common in infants and young children, and include pneumonia, hypoxia, apnea, seizures, encephalopathy, and malnutrition. Sudden infant death syndrome (SIDS) can be the manifestation of pertussis in young infants. In adults and adolescents protracted coughing episodes may also cause sleep disturbance, urinary incontinence, subconjunctival hemorrhaging, rib fractures, or other sequelae. Pertussis is transmitted through direct contact with discharges from respiratory mucous membranes of infected persons or via aerosolized droplets from coughing and sneezing. Recent experimental data in primates confirmed existence of airborne transmission of pertussis which has long been suspected (*Warfel et al, JID, 2012*). The incubation period ranges from 5-21 days, and is usually 7-10 days. Around 80% of susceptible household contacts of pertussis patients develop the disease. Transmission also occurs in child care settings, schools, clinics, and institutions including hospitals. Pertussis vaccination reduces transmissibility. Children who are too young to be fully vaccinated or who have not completed the primary vaccination series are at highest risk for severe illness.^{1,4}

Pertussis is endemic in the U.S. and worldwide. The best way to prevent pertussis is keeping up-to-date with recommended pertussis vaccines and practicing good [cough etiquette](#). Also, keep infants and other people at high risk for pertussis complications away from infected people. There are vaccines for infants, children, preteens, teens, and adults. Children, adolescents, and adults who are partially protected by vaccine may become infected and have milder symptoms that go unrecognized as pertussis. Therefore, they are an important reservoir of infection for younger children. Between 2004 and 2005, approximately

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60% of the reported U.S. pertussis cases were adolescents or adults.⁵ The majority of states in the U.S. reported increases in pertussis activity in the first half of 2012 (compared to the same time period in 2011), with several states including Missouri reporting high rates of the disease. Infants, children 7 to 10 years, and adolescents ages 13 to 14 years represent the age groups with the highest incidence rates in the mid-year 2012 report.²

For a complete description of pertussis, refer to the following texts:

- *Control of Communicable Diseases Manual*. (CCDM), American Public Health Association. 19th ed. 2008
- American Academy of Pediatrics. *Red Book: 2012 Report of the Committee on Infectious Diseases*. 29th ed. 2012.

2014 Case Definitions⁶

Clinical Criteria

In the absence of a more likely diagnosis, a cough illness lasting ≥ 2 weeks, with at least one of the following signs or symptoms:

- Paroxysms of coughing; or
- Inspiratory whoop; or
- Post-tussive vomiting; or
- Apnea (with or without cyanosis) (FOR INFANTS AGED <1 YEAR ONLY)

Laboratory Criteria for Diagnosis

- Isolation of *B. pertussis* from a clinical specimen
- Positive PCR for pertussis

Epidemiologic Linkage

Contact with a laboratory-confirmed case of pertussis*.

Case Classification

Probable

- In the absence of a more likely diagnosis, a cough illness lasting ≥ 2 weeks, with At least one of the following signs or symptoms:
 - Paroxysms of coughing; or inspiratory "whoop"; or
 - Post-tussive vomiting; or
 - Apnea (with or without cyanosis) (FOR INFANTS AGED <1 YEAR ONLY)

And

Absence of laboratory confirmation;

And

No epidemiologic linkage to a laboratory-confirmed case of pertussis.

OR, **FOR INFANTS AGED <1 YEAR ONLY:**

- Acute cough illness of any duration, with At least one of the following signs or symptoms:
 - Paroxysms of coughing; or

(Continued on next page)



Pertussis (continued)

- Inspiratory "whoop"; or
- Post-tussive vomiting; or
- Apnea (with or without cyanosis)

And

Polymerase chain reaction (PCR) positive for pertussis.

OR, **FOR INFANTS AGED <1 YEAR ONLY:**

- Acute cough illness of any duration, with

At least one of the following signs or symptoms:

- Paroxysms of coughing; or
- Inspiratory "whoop"; or
- Post-tussive vomiting; or
- Apnea (with or without cyanosis)

And

Contact with a laboratory-confirmed case of pertussis.

Confirmed

- Acute cough illness of any duration, with isolation of *B. pertussis* from a clinical specimen.

OR

- Cough illness lasting ≥ 2 weeks, with

At least one of the following signs or symptoms:

- Paroxysms of coughing; or
- inspiratory "whoop"; or
- Post-tussive vomiting; or
- Apnea (with or without cyanosis) (FOR INFANTS AGED <1 YEAR ONLY)

And

Polymerase chain reaction (PCR) positive for pertussis.

OR

- Cough illness lasting ≥ 2 weeks, with at least one of the following signs or symptoms:

- Paroxysms of coughing; or
- inspiratory "whoop"; or
- Post-tussive vomiting; or
- Apnea (with or without cyanosis) (FOR INFANTS AGED <1 YEAR ONLY)

And

Contact with a laboratory-confirmed case of pertussis*.

Case Classification Comment(s)

*Note: An illness meeting the clinical case definition should be classified as "probable" rather than "confirmed" if it occurs in a patient who has contact with an infant aged <1 year who is Polymerase Chain Reaction (PCR) positive for pertussis and has ≥ 1 sign or symptom and cough duration <14 days (classified as "probable" case).

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Information Needed for Investigation

Verify the diagnosis. For all pertussis cases prior to case classification; obtain demographic, clinical, laboratory information, and other epidemiological information necessary to complete the [Disease Case Report \(CD-1\)](#). Complete the [Pertussis Report Form](#) on all probable and confirmed cases. The information to complete the forms can be obtained from the attending physician, hospital, laboratory, patient, or a knowledgeable family member. **NOTE:** Early diagnosis and treatment might limit disease spread. When pertussis is strongly suspected, attempts to identify and provide prophylaxis to close contacts should proceed without waiting for laboratory confirmation. When suspicion of pertussis is low, the investigation can be delayed until there is laboratory confirmation of the diagnosis. However, prophylaxis of infants and their household contacts should not be delayed because pertussis can be severe and life-threatening to young infants.

Investigators should make every attempt to collect information on paroxysms of cough, whoop, post-tussive vomiting, and duration of cough as these variables are required to determine whether an individual meets the clinical case definition for pertussis. When feasible, case investigations initiated shortly after cough onset should include follow-up calls to collect information on cough duration. Follow-up calls should be done regardless of confirmatory test results so that cases meeting the clinical case definition can be reported. **NOTE:** The limitations of laboratory diagnostics make the clinical case definition essential to pertussis surveillance. It is important to determine duration of cough - specifically whether it lasts 14 days or longer; in order to determine if a person's illness meets the definition of a clinical case. If the first interview of a suspect pertussis case is conducted within 14 days of cough onset and cough is still present at the time of interview, it is important to follow up at 14 days or later after onset.

Identify all household contacts and other close contacts at high-risk of severe illness. Antimicrobial treatment does not generally lessen the severity of disease unless it is begun in the catarrhal phase, prior to paroxysmal coughing. However, treatment reduces transmission and is essential for disease control. The spread of pertussis can be limited by decreasing the infectivity of the patient and by protecting close contacts. Additional information on [Postexposure Antimicrobial Prophylaxis](#) can be found later in this document.

Establish the extent of illness. Determine whether household or other close contacts are or have been ill with symptoms compatible with pertussis by contacting the health care provider, patient or family member. For information on the clinical features of pertussis, please refer to CDC's website at: <http://www.cdc.gov/pertussis/clinical/features.html>. If the case is a child who attends a child care facility or a school, determine whether any other children in that setting are or have been ill with symptoms compatible with pertussis.

Identify the most likely source of infection and risk factors for the spread of the disease.

- Identify symptomatic household and other close contacts and obtain or recommend specimen collection and testing (see [Laboratory Procedures](#)).
- Have the case and all appropriate close contacts been treated with an antibiotic recommended for use in treatment of pertussis (see Treatment and Post-exposure Prophylaxis)?
- Does the case or a member of the case's household attend a child care center, nursery school, or any other school setting?



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- Does the case or a member of the case’s family work as a health care provider or other high risk setting?
- Determine the immunization status of the case and close contacts.
- Has the case traveled to an area where there is a known outbreak or increased pertussis activity?

Provide information on pertussis to persons at risk for infection and the general public. Efforts should be made to promote pertussis awareness and provide prevention information to the public to reduce the risk of disease. Pertussis can cause serious and potentially life-threatening complications in infants and young children who are not fully vaccinated. For information on possible clinical complications of pertussis, see CDC’s website at: <http://www.cdc.gov/pertussis/clinical/complications.html>.

An excellent informational sheet, [Pertussis \(Whooping Cough\): Question-&-Answers, Information about the disease and vaccines](#) is available from the Immunization Action Coalition. Additional resources are also available on CDC’s website at: <http://www.cdc.gov/pertussis/>.

Pertussis Surveillance. Review WebSurv to determine whether there have been other cases related by person, place, or time, to identify clusters of related cases that might indicate an outbreak. Surveillance data collected through the [Pertussis Report Form](#) is used to assess burden of disease and monitor changes in epidemiology over time. Therefore surveillance data can be used to characterize populations or geographic areas in which additional efforts may be needed to raise awareness and reduce disease incidence.

Notification

- Contact the [District Communicable Disease Coordinator](#), the [Senior Epidemiology Specialist](#) for the District, or MDHSS’ – Bureau of Communicable Disease Control and Prevention (BCDCP), phone (573) 751-6113, Fax (573) 526-0235, or for after hours notification contact the MDHSS’ ERC at (800) 392-0272 (24/7) immediately if an outbreak* of pertussis is suspected.
- If a case(s) is associated with a childcare center, BCDCP or the LPHA will contact the Bureau of Environmental Health Services (BEHS), phone (573) 751-6095, Fax (573) 526-7377 and the Section for Child Care Regulation, phone (573) 751-2450, Fax (573) 526-5345.
- If a case(s) is associated with a long-term care facility, BCDCP or the LPHA will contact the Section for Long Term Care Regulation, phone (573) 526-8524, Fax (573) 751-8493.
- If a case is associated with a hospital, hospital-based long-term care facility, or ambulatory surgical center, BCDCP or the LPHA will contact the Bureau of Health Services Regulation phone (573) 751-6303, Fax (573) 526-3621.

*Outbreak is defined as the occurrence of illness(es) similar in nature, in a community or region, clearly in excess of normal expectancy and derived from a common or a propagated source.

Control Measures^{1, 2, 5, 7, 8, 9, 15}

The best way to prevent pertussis is by being fully vaccinated and practicing good [cough etiquette](#). Infected people should be isolated from infants and other people at high risk for pertussis complications.

Immunization:^{5, 7, 8} Immunization with a pertussis containing vaccine is an important control measure that has resulted in a dramatic decrease in the incidence of pertussis in the United States. In 2011, the Advisory Committee on Immunizations Practices (ACIP) expanded recommendations on pertussis-containing vaccine to include all age groups. Universal immunization of infants and children less than 7 years is recommended.



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In addition, it is believed that widespread boosting of pertussis immunity in older children, teens and adults can bring down pertussis incidence and mortality in the U.S. Pertussis vaccine is also recommended for certain groups that may be at increased risk of transmitting the disease to infants who are at greatest risk for severe disease and death. These groups include pregnant women, family members and caregivers of an infant, and health care workers. Among health care workers, priority should be given to those who have direct contact with babies younger than 12 months of age. **NOTES:** *To reduce the risk of pertussis in new mothers and their very young infants, ACIP now recommend that pregnant women receive Tdap vaccine during each pregnancy.* A complete summary of the recommended pertussis vaccine schedule for all ages is available at: <http://www.cdc.gov/vaccines/vpd-vac/pertussis/recs-summary.htm>. *There are persons for whom the pertussis vaccine should not be given due to specific contraindications.* For a complete description of the pertussis vaccines including contraindications and precautions refer to CDC - The Pink Book⁷ at: <http://www.cdc.gov/vaccines/pubs/pinkbook/pert.html> for guidance.

Postexposure Antimicrobial Prophylaxis.¹⁵ The primary objective of postexposure antimicrobial prophylaxis (PEP) should be to prevent death and serious complications from pertussis in individuals at increased risk of severe disease.

With increasing incidence and widespread community transmission of pertussis, extensive contact tracing and broad scale use of PEP among contacts may not be an effective use of limited public health resources. While antibiotics may prevent pertussis disease if given prior to symptom onset, there are no data to indicate that widespread use of PEP among contacts effectively controls or limits the scope of pertussis outbreaks.

Another important consideration is the overuse of antibiotics; CDC is engaged in actively promoting the judicious use of antibiotics among healthcare providers and parents. Given these considerations, *CDC supports targeting postexposure antibiotic use to persons at high risk of developing severe pertussis and to persons who will have close contact with those at high risk of developing severe pertussis.*

Accordingly, CDC supports the following:

- Providing PEP to all household contacts of a pertussis case. Within families, secondary attack rates have been demonstrated to be high, even when household contacts are current with immunizations. Administration of antimicrobial prophylaxis to asymptomatic household contacts within 21 days of onset of cough in the index patient can prevent symptomatic infection.
- Providing PEP to persons within 21 days of exposure to an infectious pertussis case-patient who are at high risk of severe illness or who will have close contact with a person at high risk of severe illness. These include,
 - Infants and women in their third trimester of pregnancy - severe and sometimes fatal pertussis-related complications occur in infants aged <12 months, especially among infants aged <4 months. Women in their third trimester of pregnancy may be a source of pertussis to their newborn infant.
 - All persons with pre-existing health conditions that may be exacerbated by a pertussis infection (for example, but not limited to immunocompromised persons and patients with moderate to severe medically treated asthma).

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- Contacts who themselves have close contact with either infants under 12 months, pregnant women or individuals with pre-existing health conditions at risk of severe illness or complications.
- All contacts in high risk settings that include infants aged <12 months or women in the third trimester of pregnancy. These include, but are not limited to neonatal intensive care units, childcare settings, and maternity wards.
- A broader use of PEP in limited closed settings when the number of identified cases is small and when a community-wide outbreak is not ongoing; however, when continued transmission of pertussis is evident, multiple rounds of antibiotics would not be recommended. Rather than repeating a course of antibiotics, contacts should be monitored for onset of signs and symptoms of pertussis for 21 days.

NOTE: Antimicrobial therapy options are the same for treatment and prophylaxis, and should be recommended for cases and appropriate contacts regardless of immunization history. Azithromycin, erythromycin, or clarithromycin are appropriate first-line agents for treatment and prophylaxis (see Table 3.44 on page 556 of the Red Book, 2012). Resistance of *B. pertussis* to macrolide antimicrobial agents has been reported rarely. Penicillins and cephalosporins are not effective against *B. pertussis*. Antimicrobial agents for infants younger than 6 months of age or persons who cannot tolerate macrolides, or who are infected with a macrolide-resistant strain can require special consideration.¹ **NOTE:** *On March 12, 2013, the Food and Drug Administration (FDA) issued a warning that azithromycin can cause abnormal changes in the electrical activity of the heart that may lead to a potentially fatal irregular heart rhythm in some patients.* Azithromycin remains one of the recommended drugs for treatment and chemoprophylaxis of pertussis, but consider using an alternative drug in those who have known cardiovascular disease.² Please refer to the Red Book, 2012 or CDC’s website:

<http://www.cdc.gov/pertussis/clinical/treatment.html> for specific treatment guidance.

The local health department should be promptly notified of pertussis cases in “limited closed settings” (e.g. schools and child care operations). Additional control measures may be recommended such as:¹

1. Provide information to case(s) and exposed contacts on ways to treat and prevent transmission of pertussis.
 - Benefits of vaccination.
 - Proper antibiotic usage.
2. Instruct cases on necessary isolation.
 - Cases should refrain from contact outside of the household for the first 5 days of a full course antibiotic therapy or for 21 days from cough onset for those who did not receive therapy.
 - Case isolation inside a household may not be feasible but care should be taken to protect unimmunized infants or those at risk for complications.
3. Instruct cases and contacts to be aware of the high risk that infection poses to certain individuals, especially to infants under 6 months of age and pregnant women.
4. Counsel contacts to watch for signs or symptoms of pertussis occurring within 21 days of exposure; should symptoms develop, seek medical evaluation.
5. Medical care should be sought promptly with appropriate specimens taken and treatment considered for those with any of the signs or symptoms compatible with pertussis.



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A sample letter for notifying and educating parents/guardians of a pertussis exposure is available on CDC’s website at: <http://www.cdc.gov/pertussis/outbreaks/guidance-letter.html>. Fact sheets for parents/guardians and providers are also available in the document: [Prevention and Control of Communicable Diseases: A Guide for School Administrators, Nurses, Teachers, Child Care Providers, and Parents and Guardians](#).

Outbreaks:⁹ Pertussis outbreaks can be difficult to identify and manage. Other respiratory pathogens often cause clinical symptoms similar to pertussis, and co-circulation with other pathogens does occur. To respond appropriately (e.g., provide appropriate prophylaxis), it is important to confirm that *B. pertussis* is circulating in the outbreak setting and to determine whether other pathogens are contributing to the outbreak. PCR tests vary in specificity, so obtaining culture confirmation of pertussis for at least one suspected case is recommended any time there is suspicion of a pertussis outbreak.

NOTE: To reduce the risk of pertussis in new mothers and their very young infants, ACIP now recommends that pregnant women receive Tdap vaccine during each pregnancy. During outbreaks, prevention measures should focus on efforts to improve coverage with Tdap during pregnancy to reduce severe illness and possible deaths in vulnerable infants. CDC’s postexposure antimicrobial prophylaxis recommendations are available on their website at: <http://www.cdc.gov/pertussis/outbreaks/PEP.html>.

Active screening for symptomatic patients with suspected pertussis should be considered during outbreaks in settings such as schools, day care centers, and hospitals. Active screening for suspected cases potentially reduces exposure to persons with pertussis, encourages timely medical evaluation and treatment of cases, and promotes prompt administration of antibiotics to high risk close contacts.

Recommendations for the control of pertussis and pertussis outbreaks in health care settings can be found in the following references: <http://www.cdc.gov/mmwr/pdf/rr/rr6007.pdf>¹⁶ and <http://www.cdc.gov/hicpac/pdf/InfectControl98.pdf>.¹¹

Laboratory Procedures^{9, 13}

Determining who has pertussis and who does not is often difficult. Whenever possible, a nasopharyngeal swab or aspirate should be obtained from all persons suspected of having pertussis. *NOTE: A properly obtained nasopharyngeal swab or aspirate is essential for optimal results.* Health department personnel who are asked to obtain these specimens should receive training and supervision from persons experienced in collection of nasopharyngeal specimens. CDC has developed two short training videos for collection of nasopharyngeal aspirate and swab specimens, which can be accessed on the [CDC pertussis web site](#).

For information on the collection or shipment of specimens to the Missouri State Public Health Laboratory (MSPHL), see their website at: <http://health.mo.gov/lab/pertussis.php>.

NOTE: The MSPHL considers the following specimens unsatisfactory for testing:

- Specimens that are not labeled with the patient name or identifier.
- Specimens that are more than 5 days in transit, received warm, sent with expired media, or sent with cotton or large swabs will be considered unsatisfactory for culture if *Bordetella* is not found.



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For additional information on diagnostic testing, diagnostic confirmations, or best practices for health care professionals on the use of PCR for diagnosing pertussis, refer to CDC’s website at:

- <http://www.cdc.gov/pertussis/clinical/diagnostic-testing/index.html>,
- <http://www.cdc.gov/pertussis/clinical/diagnostic-testing/diagnosis-confirmation.html>,
- <http://www.cdc.gov/pertussis/clinical/diagnostic-testing/diagnosis-pcr-bestpractices.html>.

COMMENTS: Laboratory confirmation of pertussis is important because other pathogens can cause symptoms similar to pertussis. Several laboratory tests have been developed to test for pertussis and each of the methods have limitations. It should also be noted a positive laboratory test is not required to meet the probable case definition for pertussis. Culture of *B. pertussis* is the most specific diagnostic test; all patients with cough and a positive *B. pertussis* culture should be reported as confirmed, even those with cough lasting less than 14 days. PCR (mostly the single target tests) are less specific than culture because of cross-reactivity with other *Bordetella* spp.; cases confirmed with only a positive PCR must meet the clinical case definition to be reported as confirmed. To confirm a case by epidemiologic linkage, the case must be directly linked (i.e., a first-generation contact) to a laboratory-confirmed case by either culture or PCR. Commercial serologic tests are not included in the current pertussis case definition for pertussis. During case investigations it is important to determine what test methods were used and when the specimen was collected in relation to onset of symptoms and antibiotic therapy use.

Reporting Requirements

Pertussis is a Category 2(A) disease and shall be reported to the local health authority or to MDHSS within one (1) calendar day of first knowledge or suspicion by telephone, facsimile or other rapid communication.

As a Nationally Notifiable Condition, all pertussis cases prior to classification are a **STANDARD** report to the Centers of Disease Control and Prevention (CDC). **STANDARD** reporting requires the MDHSS to report to CDC by electronic transmission via WebSurv within the next normal reporting cycle.

1. For confirmed and probable cases, complete a [Disease Case Report](#) (CD-1) and a [Pertussis Report](#) (IMMP-25).
2. Entry of the CD-1 into the WebSurv database negates the need for the paper CD-1 to be forwarded to the District Health Office.
3. MDHSS will report to CDC following the above reporting criteria (see box).
4. Send the completed Pertussis Report to the District Health Office.
5. All outbreaks or “suspected” outbreaks must be reported as soon as possible (by phone, fax or e-mail) to the District Communicable Disease Coordinator. This can be accomplished by completing the [Missouri Outbreak Surveillance Report](#) (CD-51).
6. Within 90 days from the conclusion of an outbreak, submit the final outbreak report to the [District Communicable Disease Coordinator](#).



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