

## Topics in Occupational Medicine

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# Management of Healthcare Workers Exposed to Pertussis

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### ABSTRACT

The epidemiology of pertussis has changed in recent years. First, pertussis in adults is far more common than previously thought. Second, in many instances, the disease in adults is atypical or asymptomatic. Third, adult pertussis occurs despite a prior history of full immunization and, indeed, in persons with a prior history of natural disease.

Large outbreaks of pertussis have occurred

in healthcare facilities through failure to recognize and isolate infected infants and children, failure to recognize and treat disease in staff members, and failure to institute control measures rapidly. Appropriate use of work restriction and erythromycin prophylaxis may decrease the likelihood of institutional outbreaks (*Infect Control Hosp Epidemiol* 1994;15:411-415).

### INTRODUCTION

Although considered primarily an infectious agent of infants and young children, *Bordetella pertussis* also causes illness in adults that ranges from a mild transient respiratory infection to prolonged paroxysmal cough with post-tussive apnea and vomiting.<sup>1</sup> The potential importance of adults as reservoirs for transmission of pertussis to susceptible children has been demonstrated in recent outbreaks. Nosocomial transmission of pertussis remains a continuing problem because of failure to recognize and isolate infected infants and children, lack of highly sensitive rapid diagnostic tools, failure to appreciate that immunity following immunization wanes with time, and failure to diagnose and

manage pertussis appropriately in healthcare workers (HCWs). The objective of this report is to review the management of pertussis and pertussis exposures in HCWs.

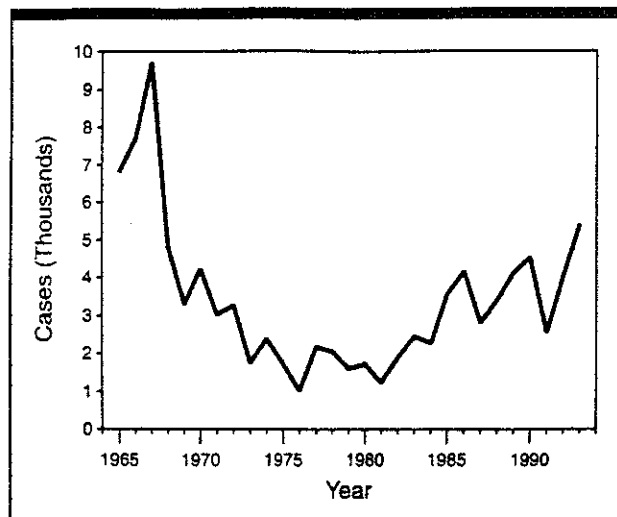
### MICROBIOLOGY

Pertussis or whooping cough is caused by *B pertussis*, a gram-negative bacillus. The *Bordetellae* are tiny (0.2 to 0.5 × 0.5 to 2.0 μm) coccobacillary organisms that appear singly or in pairs and often have a bipolar appearance.<sup>2,3</sup> The organism is a strict aerobe that exhibits optimal growth at 35°C. *B pertussis* produces a number of biologically active substances that may play a role in disease, including filamentous hemagglutinin, adenylate cyclase toxin,

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**FIGURE 1.** Reported cases of pertussis—United States, 1965–1993. (Reprinted from Centers for Disease Control and Prevention, *MMWR* 1993;42:952-953,959-960.)

dermonecrotic toxin, pertussis toxin, tracheal cytotoxin, and alpha-hemolysin.

## EPIDEMIOLOGY

Over 5,000 cases of pertussis were reported to the Centers for Disease Control and Prevention (CDC) in 1993.<sup>4</sup> However, CDC surveillance may detect as few as 10% of cases.<sup>5</sup> Pertussis incidence usually is characterized by a cyclical pattern, with peaks occurring at 3- to 4-year intervals. The increase in reported cases in 1993 coincides with the expected cyclical peak. However, the total number of reported cases has increased in each successive peak year since 1976 (Figure 1); reasons for this resurgence of pertussis are unclear. According to the CDC, the recent increase in pertussis incidence is related neither to a decrease in vaccination coverage (approximately 70% for children aged 2) nor to a substantive reduction in diphtheria, pertussis, tetanus (DPT) vaccine efficacy.<sup>4</sup>

Adolescents and young adults play an important role in transmitting pertussis to susceptible infants because vaccination-induced immunity to pertussis wanes with increasing age (beginning approximately 4 years after the last dose).<sup>6-8</sup> Furthermore, because booster immunizations are not given after the age of six, immunity in adults is boosted only through inadvertent exposure to the organism.<sup>9</sup> Bass and Stephenson<sup>10</sup> estimate that approximately 50 million adults in the United States are susceptible to pertussis and that this number will continue to increase. Adults and adolescents are also an important vector in the transmission of pertussis to children because pertussis in adults often is mild or "atypical" and frequently is not diagnosed.<sup>9</sup>

## TRANSMISSION

Humans are the only reservoirs of *B pertussis*. Transmission occurs by close contact via large aerosol droplets from the respiratory tract of symptomatic individuals. Fomites play no role in transmission.

The attack rate among immunized household contacts of children with pertussis may exceed 80%.<sup>11</sup> In highly immunized populations, the development of subclinical disease is common. Studies of intrafamilial spread reported subclinical infection in 67%<sup>11</sup> and 46%,<sup>12</sup> while studies in residences for handicapped individuals reported subclinical infections in 59%<sup>13</sup> and 73%<sup>14</sup> of residents.

## RECOGNITION OF CLINICAL DISEASE IN ADULTS

The incubation period for pertussis ranges from less than 1 week to more than 3 weeks (average, 7 to 10 days). Classically, the early phase (catarrhal) is characterized by rhinorrhea, lacrimation, mild conjunctival injection, malaise, and low-grade fever. The later phase (paroxysmal) is characterized by cough paroxysms (the "whoop"), especially in children. Patients often exhibit leukolymphocytosis, and pulmonary consolidation may occur.

Pertussis in adults is characterized by upper respiratory tract symptoms or prolonged cough; however, classic disease, including the whoop, can occur.<sup>9</sup> Steketee et al,<sup>13</sup> using enzyme-linked immunosorbent assay (ELISA) testing as the "gold standard," reported the clinical symptoms of pertussis among residents (mean age, 17) involved in an outbreak at a residential facility. Infected residents more commonly had prolonged cough (ie, 7 to 13 days, more than 14 days), cough-associated shortness of breath or vomiting, paroxysmal cough, and fever. However, 20% of infected residents did not experience any respiratory symptom.

Because the signs and symptoms usually are nonspecific, pertussis rarely is considered in adults until a child contact develops classic disease. This finding has been noted in several recent publications.<sup>7,9,11</sup>

## DIAGNOSIS

Pertussis has been diagnosed by culture, direct fluorescent antibody (DFA) techniques performed on smears, serology,<sup>15</sup> and most recently by polymerase chain reaction (PCR) tests.<sup>16</sup> Cultures must be obtained by the nasopharyngeal method<sup>2</sup> and plated on special medium, either Bordet-Gengou or Regan-Lowe (preferred because of longer shelf life). Detection often requires 3 to 6 days of growth. Although culture is the gold standard method, newer serologic methods have demonstrated that culture is not a

**TABLE**  
**OUTBREAKS OF PERTUSSIS IN HEALTHCARE FACILITIES**

Reference	Facility	Source	No. Staff	No. Staff	No. Patients	Diagnostic Method
			Infected (Attack Rate)	Symptomatic	Infected (Attack Rate)	
Kurt et al <sup>31</sup>	Acute care hospital	Patient	5	5	2	Culture, serology
Linnemann et al <sup>30</sup>	Pediatric hospital	Patient	13	4 (31%)	17	Culture
Valenti et al <sup>32</sup>	Acute care hospital	Visitor	5		2	Symptoms, serology, DFA smear
Fisher et al <sup>14</sup>	Residential facility	Unknown			44 (67%)	Serology, culture
Steketee et al <sup>20</sup>	Residential facility	HCW	42 (57%)	41 (98%)	107 (42%)	ELISA, DFA, culture
Addiss et al <sup>1</sup>	Extended care	Resident	8 (8%)	5 (71%)	38 (38%)	ELISA
Tanaka et al <sup>29</sup>	Residential facility	HCW	6 (14%)	4 (67%)	41 (82%)	Serology, culture

Abbreviations: HCW = healthcare worker, ELISA = enzyme-linked immunosorbent assay, DFA = direct fluorescent antibody.

sensitive method of diagnosis. Further, the ability to isolate *B pertussis* by culture declines significantly<sup>17</sup> when patients reach the paroxysmal phase of disease.

The DFA test for the direct detection of *Bordetella* species in human clinical specimens lacks sensitivity<sup>13</sup> and is subject to interobserver variability.<sup>3</sup> Serologic tests generally are performed by the enzyme-linked immunosorbent assay (ELISA) method with filamentous hemagglutinin and pertussis toxin.<sup>17</sup> While highly sensitive and specific, they generally are not useful for clinical diagnosis and are not available clinically.

PCR tests for the identification of *B pertussis* or its components are promising but still are in the developmental phases.

#### TREATMENT

*B pertussis* is highly susceptible in vitro to erythromycin.<sup>18</sup> Chloramphenicol, ampicillin, and oxytetracycline have moderate activity.<sup>18,19</sup> Most strains of *B pertussis* are resistant to clindamycin, methicillin, and first- and second-generation cephalosporins (eg, cephalothin, cefazolin, cefaclor).<sup>18,19</sup> Erythromycin and structurally related drugs appear to have the highest activity against *B pertussis*.

Erythromycin has been shown to decrease the duration of illness when administered early during the course of pertussis.<sup>20</sup> Its efficacy when administered during the paroxysmal stage of disease in reducing the length of clinical symptoms has been reported by some<sup>21</sup> but not all investigators.<sup>22</sup>

Treatment of infected persons with erythromycin has been shown to eliminate pertussis organisms in a few days.<sup>22</sup> Oxytetracycline and chloramphenicol also are effective in eliminating carriage, but ampicillin is not.<sup>22</sup>

Erythromycin administration to infected persons

has been shown to decrease transmission of pertussis to contacts.<sup>6,23,24</sup> Further, prophylactic administration of erythromycin during the incubation period has been shown to reduce transmission.<sup>6,20,24,25</sup> However, failures of erythromycin prophylaxis have been reported.<sup>26,27</sup>

Erythromycin is the drug of choice for the treatment and prophylaxis of pertussis. Some investigators prefer the use of the estolate preparation because it produces higher blood levels than the ethylsuccinate or stearate preparations.<sup>28</sup> However, the use of higher doses of erythromycin base (50 to 60 mg/kg/day) also has been reported to be effective. Treatment or prophylaxis requires a 14-day course of therapy.

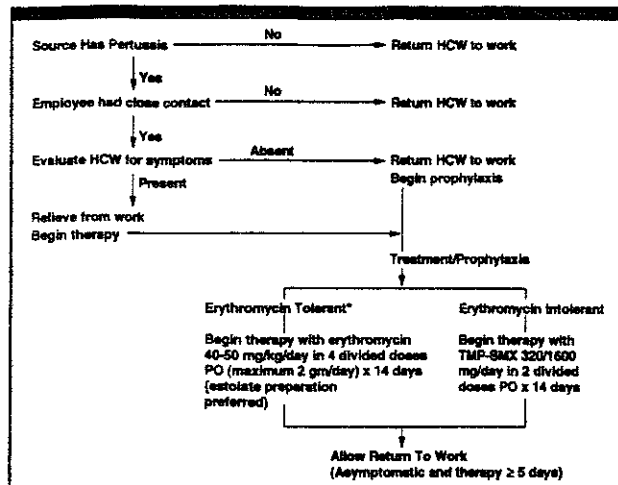
#### LESSONS FROM NOSOCOMIAL OUTBREAKS

Numerous outbreaks of nosocomial pertussis have been reported (Table).<sup>1,14,20,29,30-32</sup> These most commonly have involved residential facilities for the mentally or physical impaired<sup>20,29</sup> or pediatric wards of acute care hospitals.<sup>30-32</sup> Although the source case most commonly was an infected patient in whom pertussis was unrecognized,<sup>1,30,31</sup> infected employees<sup>20,29</sup> and the infected mother of a child with pertussis<sup>32</sup> also served as sources. Employees, however, often served as vectors for additional nosocomial cases.<sup>20,29,31</sup> In several instances, infected employees also infected members of their households.<sup>20,31,32</sup>

Widespread use of erythromycin prophylaxis has been reported to be an important adjunctive method of containing outbreaks.<sup>20,30</sup>

#### PRE-EMPLOYMENT SCREENING

At the time of initial employment, a complete immunization history should be obtained. This should



**FIGURE 2.** Evaluation and management of occupational exposures to pertussis.

include number and timing of DPT immunizations. Diphtheria tetanus boosters should be provided to employees based on standard recommendations.<sup>33</sup> Currently available pertussis vaccine is not recommended for adults. However, new acellular vaccines in development may be recommended in the future to boost immunity in HCWs.

#### EVALUATION AND MANAGEMENT OF OCCUPATIONAL EXPOSURES

The evaluation and management of occupational exposures to pertussis are diagrammed in Figure 2. Employees should be considered exposed only if the source has been documented to have pertussis (DFA or culture-positive) or if the source exhibits the appropriate clinical symptoms during a documented outbreak. Because transmission is via large droplets, employees should be considered exposed only if they have had close contact to the source without wearing respiratory protection devices. Close contact would consist of such activities as performing a complete physical examination, suctioning the patient, intubation, or bronchoscopy.

#### POSTEXPOSURE PROPHYLAXIS

Postexposure prophylaxis of exposed HCWs is recommended by the CDC<sup>33</sup> and the American Academy of Pediatrics.<sup>34</sup> Erythromycin 40 to 50 mg/kg (maximum 2 g/day) in four divided doses should be administered to all exposed HCWs. Persons with erythromycin allergies or who develop intolerance to erythromycin should receive trimethoprim-sulfamethoxazole 320 mg/1,600 mg per day in divided doses. Clarithromycin exhibits excellent *in vitro* activity against *B pertussis*,<sup>35</sup> and limited *in vivo* experience suggests that clarithromycin is effective therapy.<sup>36-38</sup>

Therefore, clarithromycin may be an acceptable alternative to erythromycin for use in prophylaxis with a reduced incidence of toxicity, principally gastrointestinal distress.

Symptomatic employees with known pertussis exposure should be relieved from work activities within healthcare settings. A nasopharyngeal swab should be obtained for a *B pertussis* culture, and appropriate therapy should be initiated. Asymptomatic employees with a known pertussis exposure should be placed on prophylactic therapy and instructed to return to employee health for the development of symptoms consistent with pertussis. Infected employees should be counseled regarding the possibility of transmitting pertussis to household members and advised regarding the need for prophylaxis.

Symptomatic employees should be allowed to return to work when asymptomatic and clinically improved, provided the duration of therapy has been at least 5 days.

#### FUTURE RESEARCH NEEDS

The management of occupational exposures to pertussis would benefit from additional research in several areas. First, a highly sensitive and specific method for the rapid identification of persons infected with *B pertussis* should be developed. Second, the efficacy of trimethoprim-sulfamethoxazole for the treatment and prophylaxis of pertussis in erythromycin allergic or intolerant patients should be explored. Third, the efficacy of the new macrolides, azithromycin and clarithromycin, for the treatment and prophylaxis of pertussis should be studied. Finally, the use of the new acellular pertussis vaccine for boosting immunity in adult HCWs is being pursued further.<sup>39</sup>

#### CONCLUSION

As noted by Mortimer,<sup>40</sup> the epidemiology of pertussis has changed in recent years. First, pertussis in adults is far more common than previously thought. Second, in many instances, the disease in adults is atypical or asymptomatic. Third, adult pertussis occurs despite a prior history of full immunization and, indeed, in persons with a prior history of natural disease.<sup>40</sup>

Large outbreaks of pertussis have occurred in healthcare facilities through failure to recognize and isolate infected infants and children, failure to recognize and treat disease in staff members, and failure to institute control measures rapidly. Appropriate use of work restriction and erythromycin prophylaxis may decrease the likelihood of institutional outbreaks.

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