

Pertussis in Adolescents and Adults: Nothing to Cough At!

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Introduction

Pertussis is an endemic, highly communicable, vaccine-preventable respiratory tract infection caused by the Gram-negative rod, *Bordetella pertussis*. The highest burden is in the age groups with the least immunity (infants under 6 months of age and individuals over 10 years old). It is particularly problematic in young, pre-vaccine infants and incompletely vaccinated children (Centers for Disease Control and Prevention (CDC), 2010a).

Pertussis is one of the 10 most common causes of death in childhood and it remains in fifth place among the leading etiologies of vaccine-preventable deaths in children around the world. The impact of this disease is considerable in North America, Latin America, Europe, and other parts of the world (Ulloa-Gutierrez, 2009).

A total of 20 to 40 million cases of pertussis are reported annually in the world, 90% of which occur in developing countries; pertussis results in 200,000 to 400,000 deaths per year, most of which are reported in young infants (Leung, Robson, & Davies, 2007). However, under-diagnosis and under-reporting mean that the true burden of pertussis is still underestimated (Cherry, 2010; CDC, 2010a; Leung, et al., 2007; Wood & McIntyre, 2008).

(Continued on page 3)

Editor's Note: *Dr. Golding spent part of his preventive medicine residency with the Division of Acute Disease Epidemiology, where he participated in outbreak response and focused on provider education for pertussis, especially in adult patients. This article is a product of that work.*

Keep up with SC Flu data each week:
www.scdhec.gov/health/disease/acute/flu.htm

Changes in the List of Reportable Conditions for 2011

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As of January 1, 2011, there is one new condition reportable to SC DHEC by laboratories, Carbapenem-resistant enterobacteriaceae (CRE). Additionally, reporting criteria have been expanded, clarified, or updated for several conditions, as indicated below. The List of Reportable Conditions is available from the SC DHEC website: <http://www.scdhec.gov/health/disease/reportables.htm>.

CRE: Added to list for Laboratory Reporting

Starting in 2011, infection with **Carbapenem-resistant enterobacteriaceae (CRE)** is routinely reportable (within 7 days) to DHEC by laboratories. Clinicians are

(Continued on page 2)

INSIDE THIS ISSUE

Pertussis in Adolescents and Adults: Nothing to Cough At! 1

- SC Medical Board Statement on PEP 9
- Guidelines for Pertussis-containing Vaccines 10
- Resources for Patient Education 14

Changes in the List of Reportable Conditions for 2011 1

Year-to-Date Reportable Diseases 15

Read Epi Notes online:
<http://www.scdhec.gov/health/disease/docs/EpiNotes.pdf> (latest issue)

Changes in the List of Reportable Conditions for 2011

(Continued from page 1)

advised to consider carbapenem-resistant enterobacteriaceae (CRE) in their differential diagnosis of difficult to treat infections, especially in intensive-care unit patients.

Background: Infection with carbapenem-resistant enterobacteriaceae (CRE) is increasingly becoming a health-care challenge. Up to this point, CRE has caused healthcare-associated infections, and usually affects those with compromised immune function. The most common type of CRE is the *Klebsiella pneumoniae* carbapenemase (KPC) -producing organism. KPC-producing enterobacteriaceae are widespread in the US and other countries.

From January to June 2010, three enterobacteriaceae isolates carrying the New Delhi metallo-beta-lactamase (NDM-1) resistance mechanism were identified from three US states at the CDC antimicrobial susceptibility laboratory. While uncommon in the US, organisms carrying this mechanism of resistance have been seen here and in the United Kingdom, especially among patients who had received medical care in India and Pakistan. Similarly, all three US isolates were from patients who had recently received recent medical care in India. While KPC production has most commonly been seen in *Klebsiella pneumoniae*, it has also been reported in other pathogens, such as *Escherichia coli*, *Salmonella spp.*, *Serratia spp.*, *Pseudomonas spp.*, and others.

Dengue: Submit Confirmatory Specimens

Dengue (*Flavivirus*) has been added to the list of conditions for which isolates, broths, and serum are to be submitted to the DHEC Bureau of Laboratories for confirmatory testing or genotyping.

HIV/AIDS: Report positive EIA tests

Positive EIA has been added to the list of HIV detection tests that must be reported to DHEC.

Influenza, Pediatric Deaths reportable in 24 hours

Confirmed deaths from influenza in persons younger than 18 years of age are now urgently reportable to DHEC (within 24 hours.) For these cases, influenza is confirmed by culture, RT-PCR, DFA, IFA, influenza rapid test, or autopsy results consistent with influenza

Outbreaks: Specimens may be requested

In an outbreak, defined as an excess number of cases or syndromes over the expected occurrence of disease within a geographic area, population group, or healthcare facility, clinical specimens may be requested from patients. Healthcare providers may be asked to assist with procurement of specimens.

Rabies Post-exposure Prophylaxis, Animal Bite Management Guidelines

The print and web-based versions of the List of Reportable Conditions point providers to DHEC's *Guide to Managing Animal Exposures and Rabies Postexposure Prophylaxis*. This guidance includes phone numbers for during work hours and after-hours/ weekend medical and environmental health consultation.

The Guide can be accessed from the Home Page of the DHEC website (www.scdhec.gov/) or directly from this link: http://www.scdhec.gov/health/envhlth/general_sanitation/rabies-resources-healthcare-providers.htm.

Copies of Reportables Posters

Contact your Regional Public Health Department for Disease Reporting Cards and for printed copies of the 2011 List of Reportable Conditions and Laboratory List of Reportable Conditions. Regional Office Contact information is available from <http://www.scdhec.gov/health/disease/reportables.htm>, where you can also download and print PDF copies of these lists.

Electronic Reporting

Call 1-800-917-2093 to learn more about electronic disease reporting, or navigate to <http://www.scdhec.gov/health/disease/chess/index.htm> for information about **CHES**, South Carolina's electronic disease reporting system.

Pertussis in Adolescents and Adults: Nothing to Cough At!

(Continued from page 1)

Pertussis in the US: By the Numbers

- Since the early 1990s, the US disease incidence in adults and adolescents has been on the increase.
- In 2004, the number of US cases doubled compared with previous years. In 2005, adolescents and adults contributed the greatest number of cases -- 60% (Leekha, Thompson, & Sampathkumar, 2009).
- In 2009, there were 16,858 cases in the US.
- In 2010, there were 21,291 cases reported through Week 52 (MMWR).
- Among children, preliminary US case rates for 2010 were estimated at 49/100,000 in infants less than 12 months of age and 8/100,000 in children 1-4 years of age. This demonstrates a high risk in young pre-vaccination

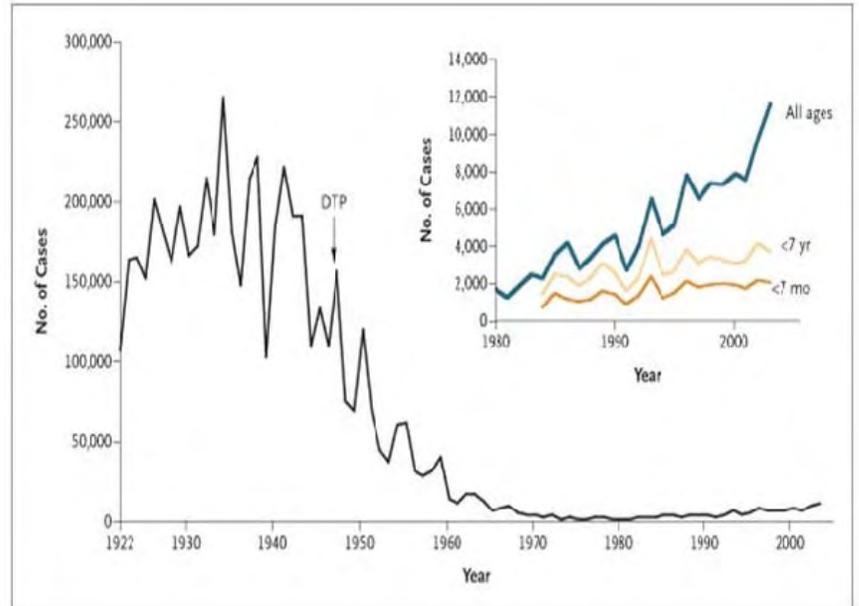


Figure 1: US Pertussis Case Trends (1922-2003) From Pertussis — Not Just for Kids (Hewlett & Edwards, 2005)

babies and incompletely vaccinated young children (CDC, unpublished data).

Pertussis in South Carolina

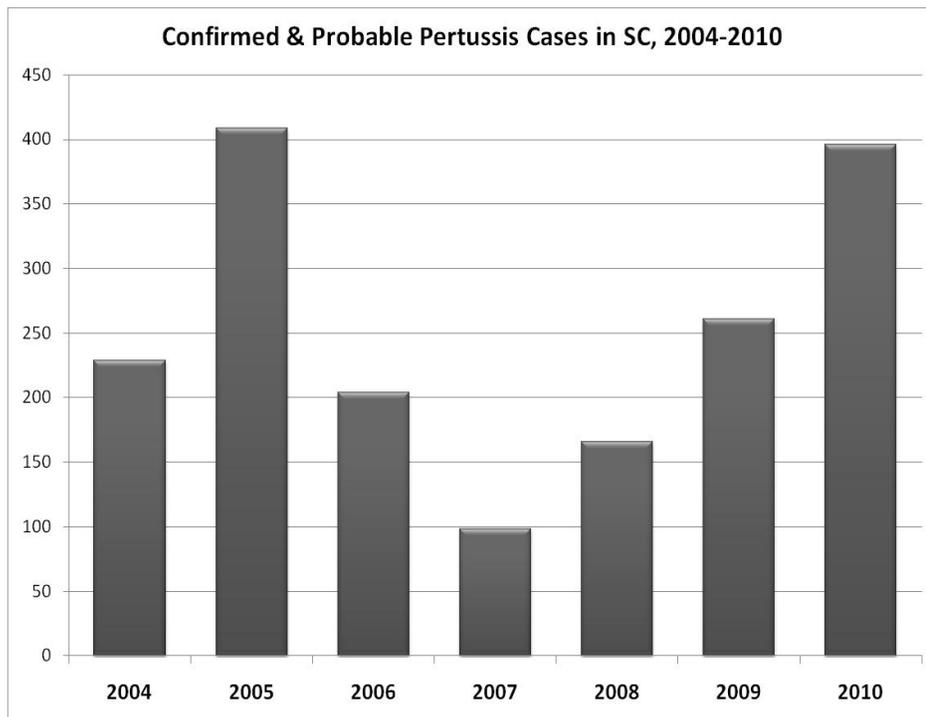


Figure 2: Confirmed and Probable Pertussis Cases in SC, 2004-2010. (SC DHEC, Division of Acute Disease Epidemiology, 2011).

In 2010, South Carolina had 391 confirmed and probable pertussis cases reported as of mid-December. This demonstrates the cyclical nature of pertussis incidence for that is also seen nationally (South Carolina Department of Health and Environmental Control (SC DHEC, 2010) The putative reasons for the state and national increases in total pertussis incidence as well as the increasing adolescent and adult proportions are enumerated below.

Sc data indicate that total disease rates are rising. They also demonstrate a considerable proportion of cases in “non-children” (i.e., adolescents and adults), as demonstrated in Figure 3 (page 4)

Pertussis Epidemiology

The only known reservoir for *B. pertussis* is human adolescents and adults with waning humoral and cell-mediated immunity from childhood vaccination or

(Continued on page 4)

Pertussis in Adolescents and Adults: Nothing to Cough At!

(Continued from page 3)

disease. As both vaccine and naturally acquired immunity decrease over time, young infants with inadequate immunity and small airways are at very high risk from exposure to these newly susceptible adolescents and adults.

Pertussis tends to become epidemic every 2-5 years; a trend unchanged from the years before vaccine introduction. Outbreaks occur throughout the year in the US (Cherry, 2010; CDC, 2010b). Pertussis vaccination has reduced the case incidence in peak years by more than 95%.

Pertussis outbreaks are not uncommon. California reported 8,383 pertussis cases in 2010 (21.4 cases/100,000), the highest number since 9,394 cases were reported in 1947, and the highest incidence since 1958, when 26.0 cases/100,000 were reported. There were 10 infant deaths from pertussis in California in 2010, nine of whom were unvaccinated infants under 2 months of age (California Department of Public Health, Immunization Branch, 2011). In Michigan, an increase was noted in mid- 2008 and it has continued to date. This has compounded a long-term increase in cases since the early 1990s. Moreover, as of October 31, there were 902 cases reported for 2010. By comparison, in 2008 and

(Continued on page 6)

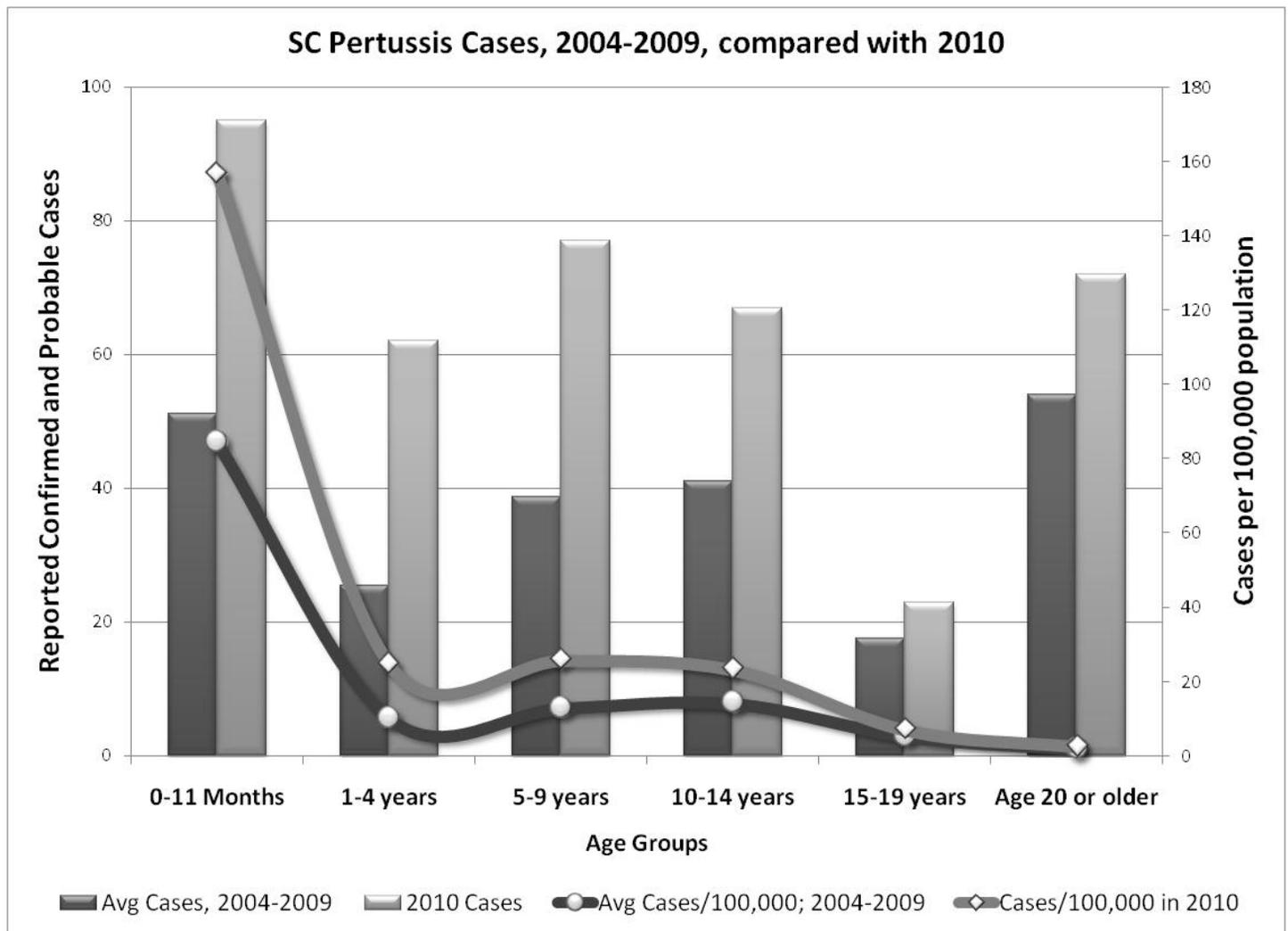


Figure 3: Age-Specific Cases and Case Rates. (SC DHEC, Division of Acute Disease Epidemiology, 2010). 2010 case numbers and rates were markedly increased over those from 2004-2009. The attack rates are much higher in young infants with little to no immunity and very small airways. The only known reservoir is adolescents and adults with waning immunity. Pertussis is not only a childhood disease; as adolescent and adult immunity wane, they may become infected and, in turn, infect young babies without immunity.

Pertussis in Adolescents and Adults: Nothing to Cough At!

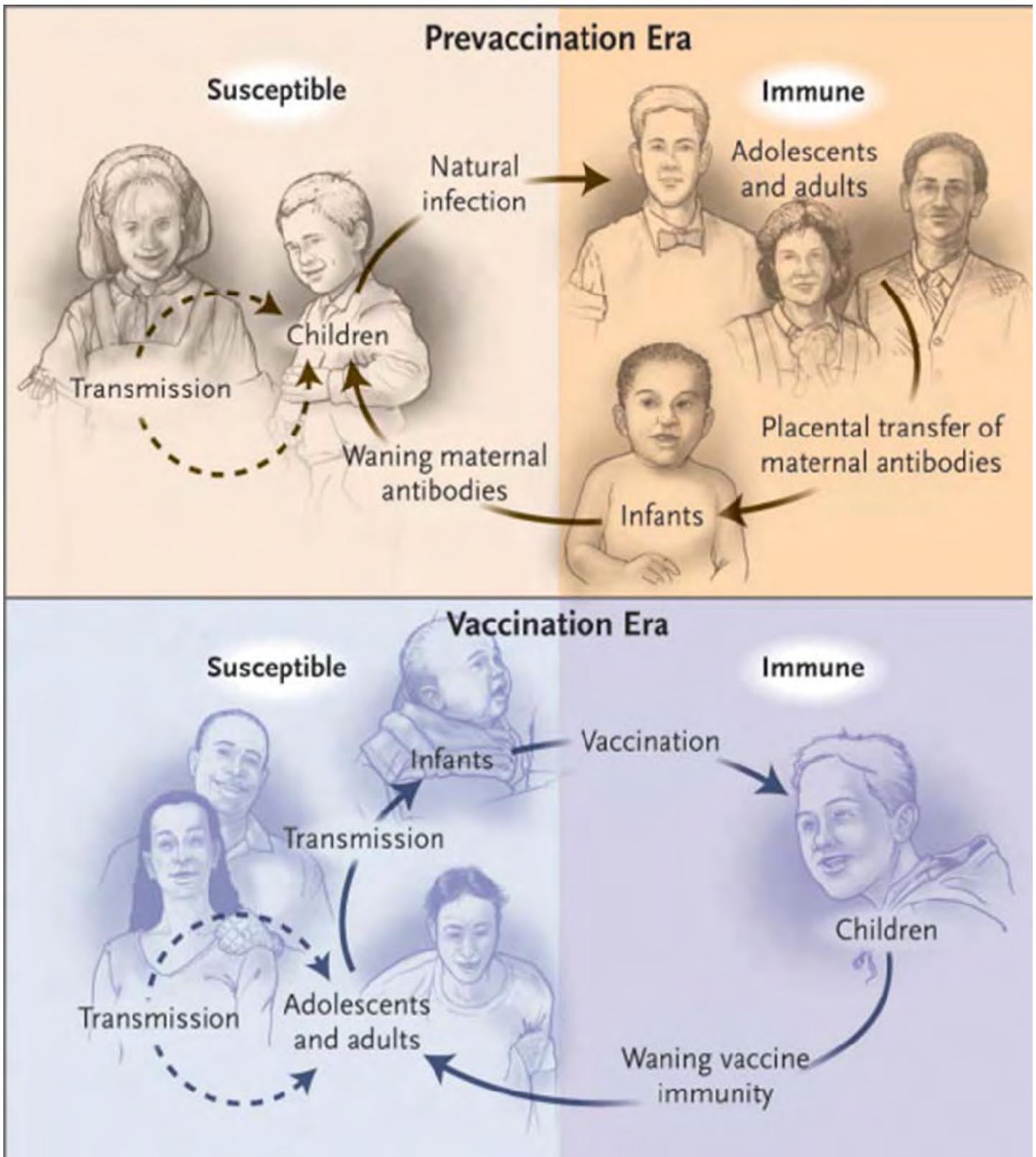


Figure 4: The Epidemiological Cycles of Pertussis before and after the Vaccine Introduction. (From Hewlett & Edwards, 2005)

Pertussis in Adolescents and Adults: Nothing to Cough At!

(Continued from page 4)

2009, 315 and 902 cases were reported, respectively for the complete year (CDC, 2010b).

The Impact of Pertussis Vaccine

In the pre-vaccine era, pertussis was one of the most common and contagious childhood respiratory infectious diseases and a major cause of childhood morbidity and mortality in the United States. The whole-cell pertussis vaccine became available in the 1940s. At the time of vaccine introduction, the infection was universally present with cyclic peaks every 2–5 years. Cases were seen primarily in children under 10 (93% of cases). Ten percent of the cases involved infants. The introduction of the diphtheria, tetanus toxoid and whole cell pertussis (DTP) vaccines changed the rate of reported pertussis from 157 per 100,000 in the prevaccine era to <1 per 100,000 in the 1970s. In the 1970s, 50% of the reported cases were observed in infants and few cases were noted in adults. However, now about 65% of reported cases occur in persons over 10 years of age (Cherry, 2010).

“Vaccine Era” Epidemiology

Since widespread use of pertussis vaccine began, incidence has decreased more than 80% compared with the pre-vaccine era. However, despite the widespread availability of an effective vaccine for decades, there has been a significant resurgence in pertussis cases, beginning in the 1980s. This resurgence has been greatest among 10 to 19 year olds and infants younger than 6 months of age, (Cherry, 2006). Moreover, from 2001 to 2003, persons >10 years of age accounted for 56% of reported cases, more than double the 24% they accounted for from 1990 to 1993. In 2005, the incidence of reported pertussis was 8.6 per 100,000 persons (CDC, 2008a). In 2008, more than 13,000 cases of pertussis were reported—and many more cases go unreported.

Despite this trend in older persons, incidence remains highest in young infants. In 2005, most (38 of 39) pertussis-related deaths reported to CDC were among infants aged <6 months, who were too young to have received three doses of DTaP vaccine.

Many industrialized countries with long established immunization programs are currently experiencing resurgences of pertussis despite universal vaccination with high uptake. The posited etiologies of this phenomenon are many including:

- Lessened potency of acellular vaccine,

- Mutations in *B. pertussis*,
- Better and quicker laboratory identification, especially polymerase chain reaction (PCR),
- Greater clinical awareness of pertussis in the medical and public health communities, including increased surveillance and reporting, and
- The increased proportion of adolescents and adults cases over the last quarter-century. As adolescents' vaccine-induced immunity wanes, their disease susceptibility increased. (Cherry, 2010).

Despite increased incidence of disease and increased awareness of pertussis, CDC believes that much of pertussis disease still goes unrecognized and unreported (Cherry, 2010; CDC, 2010a). This may be associated with the **wide variation in presenting symptomatology** associated with disease in a population experiencing age-related gradual decrease of disease protection (CDC, 2010a; Leung, et al., 2007; Wirsing von König, Halperin, Riffleman, & Guiso, 2002; Wood & McIntyre, 2008).

It is axiomatic that effective prevention and treatment of pertussis depends on the health care community's knowledge of the epidemiology and pathobiology of the disease. **All too frequently, however, pertussis is not even “on the radar screen” of medical providers and it is often not part of the differential diagnosis of prolonged and/or atypical cough of adolescents and adults.** This under-diagnosis and under-appreciation of pertussis in adolescents and adults is a major impediment to disease treatment and control (Rossi-Foulkes, et al., 2010), since adolescent and adult cases do not necessarily fit the classic “whooping cough” case picture. In fact, the distinct clinical phases of the disease and the characteristic whoop occur infrequently in adolescent and adults patients. (Leekha, et al., 2007).

Overall, signs and symptoms in adolescents and adults are less typical than the “classic” presentation seen in unvaccinated children

It may be of value to compare the “Classic” presentation of pertussis, described in the pediatric, non-immune population, with the atypical symptomatology observed in older, partially/formerly immune patients.

(Continued on page 7)

Pertussis in Adolescents and Adults: Nothing to Cough At!

(Continued from page 6)

“Classic” *B. pertussis* infection in the non-immune is characterized by 3 phases:

- **Catarrhal stage**
 - Usually 1 to 2 weeks in length, signs, and symptoms non-specific making diagnosis difficult. May seem to be a viral URI with generalized malaise, rhinorrhea, and mild cough.
 - Low-grade fever may be present, **but significant fever is atypical**.
 - Early excessive lacrimation and conjunctival injection are seen.
 - Recent sick contacts: the incubation period for *B. pertussis* is relatively long (7-10 days) compared with most viral URIs (1-3 days).
 - Exposure to a person with a cough illness 1 to 2 weeks prior to symptoms-onset (especially a high-risk contact, e.g., one working with children or living in a low vaccine coverage area.)
- **Paroxysmal stage**
 - Follows the catarrhal stage with hallmark **coughing spells**.
 - A series of coughs during a single expiration; often occur in groups throughout the day and night, feel and look well between paroxysms.
 - Causes low lung volumes, prompting vigorous inspiration that may result in a **whoop**, more often heard infants and children with small airways.
 - Very dramatic and not soon forgotten cough presentation. (See www.immunization.org for audio and video of examples of infants and children with the infection.) Other typical symptoms include post-tussive emesis or syncope (The Group on Immunization Education of the Society of Teachers of Family Medicine, 2010.)
- **Convalescent stage**
 - After about 2 to 3 months, there is a gradual transition to the convalescent phase.
 - Persistent but decreased frequency/ severity of cough.

- It is reported that the traditional Chinese medicine calls pertussis the “the 100-day cough” (Cornia, Hersh, Lipsky, Newman, & Gonzales, 2010; Gregory, 2006).

“Atypical Pertussis” Diagnostic Considerations for the Non-Child Patient

Pertussis symptoms in previously immunized or infected adolescents and adults are more variable and often atypical. Persistent, uncharacteristic cough may be the sole presenting sign of the disease (Cornia, et al., 2010; Dworkin, 2005; Gregory, 2006; Hewlett & Edwards, 2005).

All too frequently, pertussis is not even “on the radar screen” of medical providers and it is often not part of the differential diagnosis of prolonged and/or atypical cough of adolescents and adults.

Studies have shown that around 12 to 32 % of adolescents and adults with a prolonged cough (>6 days) have serologic evidence of *B. pertussis infection* and that the symptoms and complications due to pertussis may be very different from those observed in infants and children. Scratchy throat, trouble swallowing and other pharyngeal complaints occur in ~30% of adults with pertussis. In addition, diaphoretic episodes are seen in 40 to 50 % of cases >30 years of age and about 70 to 99% of adolescents and adults reported paroxysmal cough (Hewlett & Edwards, 2005). Cough lasts at least 3 weeks in ~80 % of adults and adolescents, and 3 months or more in ~30 % of non-child patients. Post-tussive emesis is common but most adult patients do not whoop at the end of the paroxysm.

Overall, signs and symptoms in adolescents and adults are less typical than the “classic” presentation seen in unvaccinated children (Dworkin, 2005; Gregory, 2006; Hewlett & Edwards, 2005; Wirsing von König, 2002).

Disease Complications in Non-Child Patients

Complications of pertussis are numerous, and similar in adolescents and adults. Pneumonia is most common (2.1 to 3.5 %); seizures (0.3 to 0.6 %) and/or encephalopathy (0.1 %) are most severe sequelae among non-child

(Continued on page 8)

Pertussis in Adolescents and Adults: Nothing to Cough At!

(Continued from page 7)

patients. Other complications include cough-induced urinary incontinence in older patients, herniated discs, rib fracture, hernia, non-specific back pain, the sudden onset of hearing loss, angina, and even carotid-artery dissection. The cough may severely disturb sleep and/or cause choking. Other pertinent clinical findings may include diaphoresis and syncope. Finally, infectious complications such as sinusitis and otitis media are common (Gregory, 2006; Hewlett & Edwards, 2005).

Missed Diagnoses

Clinicians frequently do not consider **pertussis** in adolescents and adults with atypical or prolonged cough, however. The relatively long incubation period, non-specific symptomatology, difficulty culturing the organism, and the historic lack of accepted diagnostic testing have all been problematic in this regard (Cornia, et al., 2010).

The previously noted 12-32% etiologic proportion of prolonged cough illnesses being attributable to *B. pertussis* represents a reasonable pretest probability estimate for adolescents and adults. Serologic studies suggest that the rate of *B. pertussis* infection in these groups is ~ 2.0% per year. The rate of cough illnesses caused by *B. pertussis* in adolescents and adults has been estimated to be between 370 and 1500 cases per 100,000 population. The bottom line is that there are between ~ 800 000 and 3.3 million cases per year in the United States (Cornia, et al., 2010; Cherry, 2006).

Diagnosis of pertussis in adolescents and adults becomes even more difficult with the presence of residual immunity from prior vaccination. This can greatly modify the clinical presentation of pertussis in adolescents and adults. The patient may look and feel completely well between bouts of cough. Moreover, the diagnostic possibility of pertussis may be overlooked in non-child patients due to the mistaken perceptions that pertussis is solely a disease of infancy and childhood, that has been totally controlled by routine pediatric immunization, and that this immunity is life-long (Dworkin, 2005; Gregory, 2006; Hewlett & Edwards, 2005).

The provider must take a systematic approach to the diagnosis of adolescent and adult cough and develop a thoughtful and through differential diagnosis.

Determining the cough duration is a useful first step in formulating an approach. Coughs may be classified as:

- **Acute (<3 weeks):** An acute cough may be seen with serious non-infectious and infectious processes such as congestive heart failure, pneumonias of various etiologies, lung cancer, or pulmonary embolism. Acute cough is mostly commonly self-limited, viral upper respiratory tract infection (rhinovirus, etc).
- **Subacute (3-8 weeks):** A cough lasting 3-8 weeks may represent persistence of an acute viral or bacterial respiratory infection or a lower respiratory tract infection.
 - If a respiratory infection did not precede the cough, evaluation for chronic cough.
 - In smokers, in patients taking angiotensin-converting enzyme (ACE) inhibitors, the first step would be to stop.
- **Chronic (> 8 weeks):** If the cough continues, it may be most commonly caused by gastroesophageal reflux disease (GERD), asthma or postnasal drip/chronic sinusitis. Of course, TB must be considered in chronic cough, as must non-asthmatic eosinophilic bronchitis, defined by cough accompanied by sputum showing eosinophils without asthma.

In addition to these well-known causes of subacute or persistent non-child cough, providers should think of pertussis when faced with an adolescent or adult patient with subacute and chronic cough. (Cornia, et al., 2010)

Case Definitions

A case definition is epidemiologically important. However, not meeting a strict case definition should not hinder timely treatment of sick patients with appropriate symptomatology. The WHO and CDC case definitions for pertussis use different clinical criteria: the WHO definition is more appropriate for severe disease in non-vaccinated children with three or more weeks of paroxysmal coughing. It is more specific rather than sensitive. The CDC clinical case definition was formulated for disease surveillance. Here, cough duration is at least 2 weeks with either paroxysms or whooping. For adolescent and adult pertussis, the CDC definition is more appropriate. Most adult and adolescent

(Continued on page 9)

Pertussis in Adolescents and Adults: Nothing to Cough At!

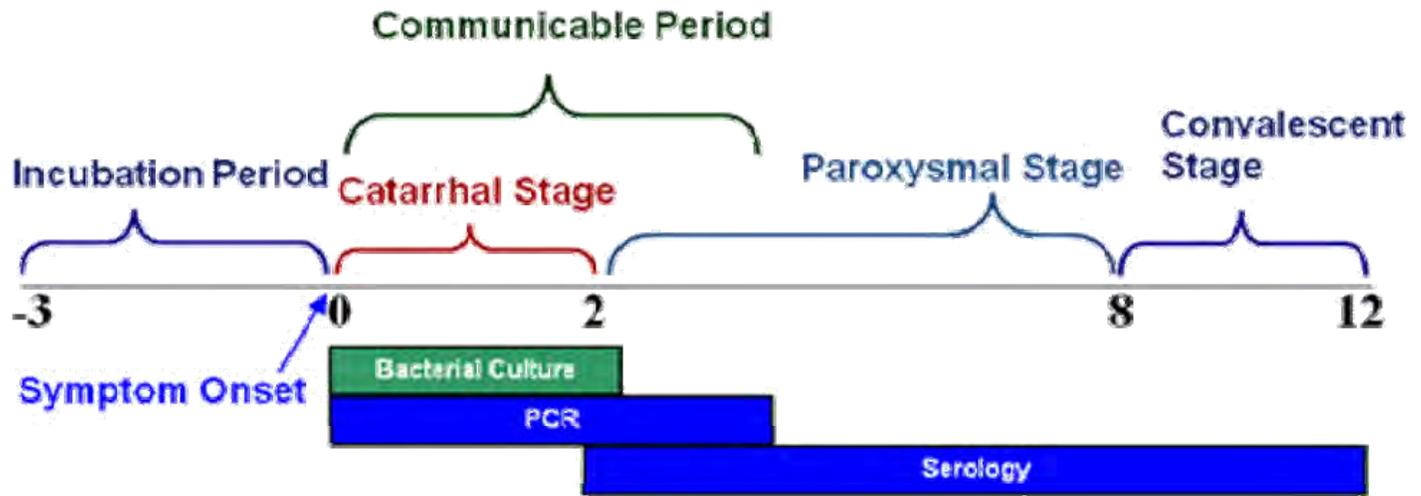


Figure 5: A Pertussis Time-Line (CDC, 2010a)

(Continued from page 8)

cases would fit the latter definition. As detailed later, culture and polymerase chain reaction (PCR) is helpful in establishing the diagnosis if a specimen can be obtained early in the course of the illness. Serology, although not meeting a surveillance case definition, can be useful when the diagnosis is not suspected until a later stage. (Wood & McIntyre, 2008)

Patients are most infective during the catarrhal stage of the disease as well as the initial two weeks of cough (*see the time line above*). Due to the perceived mildness and non-specific nature of the signs and symptoms during these early stages of the disease, the firm diagnosis of pertussis has usually not been made during this period of

maximum communicability. 90 to 100 % of susceptible non-immune household contacts exposed to a symptomatic individual during this period will develop the disease. In addition, the attack rate in household contacts older than 15 years has been reported to be as high as 80-85 % (Tan, 2005).

Treatment and Post-Exposure Prophylaxis

Treatment with a macrolide antibiotic is recommended for affected individuals; macrolide antibiotics are also recommended for post-exposure prophylaxis of all household and other close contacts. A 5-day course of Azithromycin, for treatment and prophylaxis, is well tolerated and safe (CDC, 2010a; Leung, et al., 2007; Wirsing von König, et al., 2002; Wood & McIntyre, 2008).

(Continued on page 10)

The SC Board of Medical Examiners, at its August 2010 meeting, voted to approve the following policy:

Post-Exposure Prophylaxis (PEP) is often recommended by numerous medical professional and public health organizations (notably the Centers for Disease Control [CDC], the American Public Health Association/ World Health Organization's Control of Communicable Diseases Manual, the American Academy of Pediatrics *Red Book*, or the South Carolina Department of Health and Environmental Control [DHEC]) to protect specific persons from acquiring contagious/ communicable diseases from close contact with infected persons. The SC Board examiners approves and recommends the prescribing of PEP in accordance with the most current established guidelines as published by these organizations, **even in the absence of a previously-established patient-physician relationship** (*emphasis added*).

<http://www.llr.state.sc.us/POL/Medical/PDF/PostExposureProphylaxis.pdf>

Pertussis in Adolescents and Adults: Nothing to Cough At!

(Continued from page 9)

Treatment should begin prior to receipt of laboratory confirmation in highly suspicious and/or very ill clinical cases. A PCR and culture from an appropriately obtained nasopharyngeal swab should be sent to the reference laboratory before commencing said therapy. Adjunct treatments with antihistamines, decongestants, β -

agonists, steroids or immunoglobulins have not been proven to be helpful (Gregory, 2006).

The SC Board of Medical Examiners strongly encourages providers to prescribe post-exposure prophylaxis to contacts of patients, even in the absence of an established provider-patient relationship. (See box, page 9)

(Continued on page 11)

Guidelines for Pertussis-Containing Vaccines

DTaP: (Modified from CDC, 2010a; SC DHEC, 2010)

1. DTaP ages 2, 4, 6 months (minimum start age: 6 weeks);
2. 4th DTaP dose as early as age 12 months, provided at least 6 months have elapsed since the third dose; usually given between 15-18 months of age;
3. Final DTaP dose in the series is given at age 4 through 6 years.

Tdap[§]: (CDC, 2011, p. 14)

General Recommendations

- For routine use, adolescents aged 11 through 18 years who have completed the recommended childhood diphtheria and tetanus toxoids and pertussis/diphtheria and tetanus toxoids and acellular pertussis (DTP/DTaP) vaccination series, and adults aged 19 through 64 years should receive a single dose of Tdap. Adolescents should preferably receive Tdap at the 11 to 12 year-old preventive health-care visit.

Timing of Tdap

- Can be administered regardless of interval since the last tetanus- or diphtheria-toxoid containing vaccine.

Adults Aged 65 years and Older[¶]

- Those who have or anticipate having close contact with an infant aged less than 12 months should receive a single dose of Tdap.
- Other adults ages 65 years and older may be given a single dose of Tdap.

Children Aged 7 Through 10 Years

- Those not fully vaccinated against pertussis* and for whom no contraindication to pertussis vaccine exists should receive a single dose of Tdap.
- Those never vaccinated against tetanus, diphtheria, or pertussis or who have unknown vaccination status should receive a series of three vaccinations containing tetanus and diphtheria toxoids. The first of these three doses should be Tdap.

§ As of this time, however, neither the Sanofi Aventis nor the GlaxoSmithKline Tdap booster is approved for children aged 7 to 10 or adults 64 or older. Both GSK and Sanofi have stated they intend to seek approval from the FDA to broaden the age ranges for Tdap to include both groups. Until then, providers can give the vaccine on an off-label basis (Steenhuysen, 2010).

* Fully vaccinated is defined as 5 doses of DTaP or 4 doses of DTaP if the fourth dose was administered on or after the fourth birthday.

¶ Further recommendations on the use of both Tdap vaccines in adults aged 65 years and older will be forthcoming should one or more Tdap products be licensed for use in this age group. (CDC, 2011).

Pertussis in Adolescents and Adults: Nothing to Cough At!

(Continued from page 10)

Vaccination

With pertussis thought of as a childhood disease, physicians may overlook opportunities to provide pertussis vaccinations to adolescents and adults. Emblematic of this are the results of a 2008 survey of Illinois physicians. Although the CDC Advisory Committee on Immunization Practices (ACIP) has recommended the pertussis booster vaccination for all adolescents and adults up to the 64 years of age since 2006, the survey showed that Tdap coverage in adolescents 13-17 years was 40.8%, compared with 72.2% for Td vaccine (Rossi-Foulkes, et al., 2010).

In addition, review of medical board preparation materials extent during this same period of time demonstrated gaps in pertussis-related educational coverage. A major effort aimed at increasing adult provider appreciation of the clinical impact of adolescent and adult pertussis is needed. Baseline and follow-up data quantifying physician knowledge may help target educational efforts and facilitate pertussis vaccination and reporting (Rossi-Foulkes, et al., 2010).

Two adolescent and adult formulations of acellular pertussis vaccine (Tdap) are licensed in North America and Europe. Both are combined with an adult formulation of diphtheria and tetanus toxoids. In the US, Adacel® (Sanofi Pasteur, Toronto, Ontario, Canada) is licensed for use in individuals aged 11 to 64 while Boostrix® (GlaxoSmithKline Biologicals, Rixensart, Belgium) is licensed for use in the 10 to 64 age range. These vaccines are safe, immunogenic, and well tolerated (Leung, et al., 2007).

Three studies conducted with Canadian children and adolescents evaluated the safety of Tdap (Adacel®) at an interval shorter than 5 years after Td or after pediatric DTP or DTaP (David, Hemsley, Pasquali, Larke, Buxton, & Lior, 2005; Halperin, et al., 2006; Public Health Agency of Canada, 2005). The largest was an open-label study of 7,001 students aged 7-19 years. Rates of local reactions were not increased among students who had received the most recent of 5 pediatric DTP or DTaP doses, or a Td dose, ≥ 2 years before Tdap, compared with ≥ 10 years before Tdap (Halperin, et al., 2006). The other Canadian studies demonstrated similar safety when Tdap was administered at an interval of < 5 years after the previous tetanus toxoid and diphtheria toxoid-containing vaccine (David, et al., 2005; Public Health Agency of Canada, 2005).

Vaccine Strategies and Issues

Caregivers for young infants (parents, siblings, other family, and babysitters) and health care personal are very high priority vaccine candidates.

Other strategies under consideration include

- the substitution of Tdap for Td for tetanus prophylaxis during wound management;
- "cocooning" the pre-vaccine infant via vaccination of the mother immediately postpartum or in the 2nd or 3rd trimester
- vaccination of all infant caregivers (Cherry, 2010). CDC researchers estimate that 6-8% of pertussis cases are transmitted from grandparents to children. Obviously, many grandparents are over 64 with poor pertussis immunity; and
- As a future strategy, vaccination of newborns with monovalent or combined acellular pertussis vaccine between 2-5 days of age. A candidate vaccine has shown promise but it is not on the market at the present (Ulloa-Gutierrez, 2009).

To eliminate the disease and the circulation of the bacterium, however, universal childhood DTaP and decennial Tdap immunization starting in preadolescence and continuing through adulthood must be the standard of care. Adults and adolescents should obtain a Tdap booster as per current ACIP recommendations. All adolescents and adults need the vaccine, even if they have had a Td booster. SC DHEC and the CDC recommend substituting Tdap for the next Td for all adolescents and adults. In addition, they recommend a "catch-up" dose now unless the last Td was within the last 2 years (CDC, 2010a; SC DHEC, 2010). **In the future, however, it is very likely that the Tdap will replace the decadal Td for maintenance of tetanus and pertussis immunity outside of childhood** (Mertsola, et al., 2010).

Health perceptions and beliefs are also very important in control of pertussis. Studies by Omer, et al (2006; also Omer, Salmon, Orenstein, deHart, & Halsey, 2009) found that in states where non-medical exemptions were easier to obtain, the mean annual incidence of pertussis was almost twice that of states that made it more difficult.

Summary

Pertussis should never be thought of as a "zebra" in the non-child patient population. It deserves consideration in the differential diagnosis of all

(Continued on page 12)

Pertussis in Adolescents and Adults: Nothing to Cough At!

(Continued from page 11)

adolescents and adults presenting with atypical, subacute, or chronic cough. Increased awareness of pertussis among providers treating non-child patients is of the utmost importance in the ongoing battle against pertussis (Dworkin, 2005).

To reiterate, adults and adolescents with waning natural or vaccine-acquired immunity are the only known reservoir for *B. pertussis*. These infections may be, in turn, transmitted to pre-vaccine (<2 months of age) and/or incompletely vaccinated infants (incomplete DTaP primary series), among whom significant morbidity and mortality may occur. Moreover, reporting this disease to the local health department is critical to its control because both cases and their close contacts should receive post-exposure macrolide prophylaxis (Dworkin, 2005; Gregory, 2006; Hewlett & Edwards, 2005).

It bears saying again: all health care providers, not just pediatricians, need to be aware of the epidemiology and risk profile of this endemic respiratory agent. It is incumbent on all clinicians to consider pertussis in all non-child patients with appropriate symptomatology.

Ongoing Issues

During the last 25 years there has been an increase in reported pertussis from <1 case to 9 cases per 100,000 persons in 2004. In the vaccine era, the cyclic peaks of reported pertussis still occur at 2- to 5- year intervals. This indicates that the agent is circulating in the population as in the prevaccine era. If the circulation of *B. pertussis* were being impacted by immunization, one would expect an increase in the length of the inter-epidemic period similar to the increase that occurred with measles in the 1970s and 1980s.

The Dénouement

It's out there! Pertussis is endemic and circulating even in countries such as the US where high vaccine coverage has been the case for several decades. This cycle can be broken as the reservoir population becomes immune through preteen and adult Tdap immunization.

- **Do not think of pertussis as solely a pediatric problem.**
- Pertussis is solely a human disease. There are no reservoirs other than non-immune individuals. The main reservoir for the disease is adolescents

and adults with waning immunity from childhood DTP/DTaP or infection.

- Make sure pertussis is on your "radar screen" when considering the differential diagnosis of subacute or prolonged cough in adolescents and adults.
- *Bordetella pertussis* can be a deadly pathogen in young infants and children with small airways. Babies too young for vaccine and older infants without adequate humeral and cell-mediated immunity are at significant risk.
- Family members, caregivers and other close contacts with fading immunity are the persons most likely to infect at-risk infants and children.
- Pertussis can be quite problematic for adolescents and adults as well as children. It probably accounts for up to 1/3 of the cases to prolonged cough in adolescents and adults
- Adolescent and adult disease may present quite differently than the 'classic' whooping cough we all learned of during our training. They may have solely prolonged, paroxysmal coughs, no whooping, look and feel well between bouts of cough.
- Effective pediatric DTaP vaccine is widely available and widely utilized. It is safe. It is protective but immunity wanes in adolescence and adulthood
- **Get your vaccination!**
- Take the next clinical opportunity to immunize adolescent and adult patients.
- Stress to adults the health benefits for the babies and children they love (their children, grandchildren, infant siblings) and/or their patients and clients.
- Mentally link pertussis with seasonal influenza to remember vaccine importance. Both are potentially deadly respiratory diseases, but are greatly impacted by vaccination!

Pertussis in Adolescents and Adults: Nothing to Cough At!

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Links for Pertussis Patient Education Resources

- CDC—Patient-friendly review of Pertussis:
<http://www.cdc.gov/Features/Pertussis/>
- CDC—Spanish version of above page:
<http://www.cdc.gov/spanish/especialesCDC/tosferina/>
- JAMA—one-page handout on pertussis:
<http://jama.ama-assn.org/cgi/reprint/304/8/922.pdf>
- Society of Teachers of Family Medicine Group on Immunization Education:
<http://www.immunizationed.org/>
- Tdap Vac on Facebook:
<http://www.facebook.com/pages/Tdap-Vac/127068690654152>



Summary of Reportable Conditions – Jan 1, 2010 to Dec 15, 2010

Disease/Condition	Confirmed Cases	Probable Cases	Total
Aseptic meningitis	103	0	103
Campylobacteriosis	330	0	330
Cryptosporidiosis	94	25	119
Cyclosporiasis	2	0	2
Dengue Fever	5	10	15
Ehrlichiosis, chaffeensis	4	2	6
Encephalitis, West Nile	1	0	1
Giardiasis	141	0	141
Group A Streptococcus, invasive	99	0	99
Group B Streptococcus, invasive	53	0	53
Haemophilus influenzae, invasive	77	0	77
Hepatitis A, acute	20	0	20
Hepatitis B virus infection, Chronic	84	380	464
Hepatitis B, acute	58	0	58
Hepatitis C Virus Infection, past or present	3,075	24	3,099
Hepatitis C, acute	1	0	1
Influenza, human isolates	36	0	36
Legionellosis	16	0	16
Leptospirosis	0	1	1
Listeriosis	10	0	10
Lyme disease	15	10	25
Malaria	6	0	6
Mumps	4	0	4
Neisseria meningitidis, invasive (Mening. disease)	12	0	12
Novel Influenza A Virus Infections	201	0	201
Pertussis	323	68	391
Q fever	0	2	2
Salmonellosis	1,676	5	1,681
Scombroid fish poisoning	1	0	1
Shiga toxin-producing Escherichia coli (STEC)	13	1	14
Shigellosis	69	0	69
Spotted Fever Rickettsiosis	1	17	18
Strep pneumoniae, invasive	478	0	478
Streptococcus pneumoniae, invasive disease (IPD)	2	0	2
Tetanus	1	0	1
Toxic-shock syndrome, staphylococcal	1	1	2
Tuberculosis	147	0	147
Typhoid fever (Salmonella typhi)	1	0	1
Varicella (Chickenpox)	82	1	83
Vibrio parahaemolyticus	5	0	5
Vibrio spp., non-toxigenic, other or unspecified	9	0	9
Vibrio vulnificus infection	1	0	1
Yersiniosis	4	0	4

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For immediately reportable conditions, call your local county health department or, for after hours, call 1-888-847-0902. Routine reports may be phoned in to your local health department or mailed on a completed DHEC DISEASE REPORTING CARD (DHEC 1129.) Local county health

department numbers are listed on the Official List of Reportable Conditions. For a copy of the current Official List of Reportable Conditions, call 803-898-0861 or visit www.scdhec.gov/health/disease/reportables.htm.

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