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Pertussis in Virginia

Background

Pertussis was one of the most common childhood diseases in the United States in the 20th century, resulting in significant morbidity and mortality. Over 200,000 cases were reported annually prior to the availability of pertussis vaccine. Since the mid-1940s, when the vaccine was introduced, incidence decreased to a historic low of 1,010 cases in 1976. Since the early 1980s, however, incidence has increased cyclically with peaks occurring every 3 to 4 years. According to the Centers for Disease Control and Prevention (CDC), pertussis incidence continues to increase in infants too young to receive 3 doses of pertussis-containing vaccine and in adolescents and adults.[1] In the US, a total of 7,867 cases, the highest number since 1967, were reported in 2000. In 2001, a provisional total of 5,396 cases were reported.

During the years 1997-2000, 62 pertussis-related deaths were reported; 56 of these deaths occurred in children <6 months old (too young to have received the primary series of 3 doses of pertussis-containing vaccine). In 1997-2000, 20% of all reported pertussis cases required hospitalization, including 63% of all infants <6 months of age. Compared with data from 1994 - 1996, the pertussis incidence rate increased 62% among adolescents and 60% among adults. During the same period, the rate increased 11% among infants, decreased 8% among children aged 1-4 years and remained stable for children aged 5-9 years.

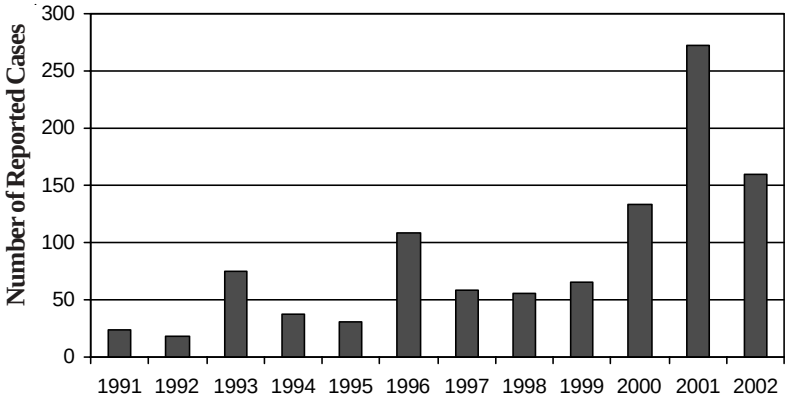
Virginia Cases

Virginia data have been similar to national trends (Figure 1). In 2001, a outbreak of pertussis cases occurred in and around Madison and Albemarle counties. Between September 25 and November 6, 2001, 97 laboratory-confirmed cases were identified in those areas. In 2002, a provisional total of 160 cases has been reported.

Age distribution for cases reported 1997-2002 may be seen in Figure 2. Children aged 10-18 years accounted for 35% of all reported cases, followed by infants (22%). Of the 164 children <1 year old, 153 (93%) were ≤6 months of age. Seventeen percent of cases were hospitalized, including 67% of cases involving infants ≤6 months (Table 1). Two pertussis-related deaths were reported (one in 1998, one in 2000), both in infants <2 months old.

Ironically, this increase in pertussis cases, both in Virginia and nationally, parallels high levels of pertussis vaccination coverage. Figure 3 illustrates the number of pertussis-containing vaccine doses received by the 429 cases (1997-2002) whose immunization status was known and who were >6 months of age. Eight-three percent had received at least 1 dose and 56% had received 5 or more doses. Seventy-eight percent of cases were fully immunized, as defined by the CDC criterion of having 3 or more doses of pertussis-containing vaccine. This increase in reported pertussis cases is not related to low vaccine effectiveness or the introduction of acellular pertussis vaccines.[1]

Figure 1. Pertussis: Virginia, 1991-2002*



**Data for 2002 are provisional.*

Factors Contributing to Increased Cases

Several factors may be involved in the upward trend of cases in the face of high vaccination levels:

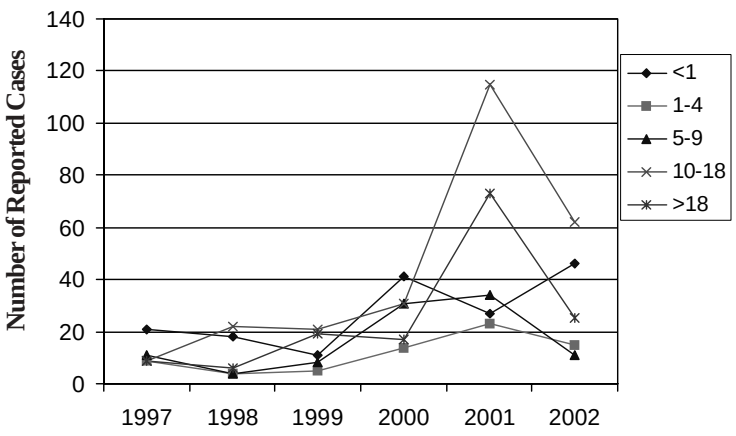
- Increased recognition of pertussis in older age groups.
- Introduction of the more sensitive polymerase chain reaction (PCR) detection of bacterial DNA as a method of confirmation in 1995.
- Changes in data collection methods to include cases without laboratory confirmation that are epidemiologically linked to another case.
- Waning immunity (no pertussis vaccine is licensed for use in persons ≥7 years old) that leaves people older than 10 years susceptible to disease.[2]
- Immunity resulting from natural infection is also not permanent.
- Mild disease, the most frequent form in all groups, contributes to transmission because it may go undiagnosed and untreated.
- Some strains of *Borde-*

tella pertussis may not be included in the vaccine.[3]

Transmission

Pertussis occurs worldwide; humans are the only known reservoir. The organism most commonly is transmitted through contact with respiratory droplets or by contact with airborne droplets of respiratory secretions. It is highly communicable; secondary attack rates are as high as 80% of susceptible household contacts. There is no distinct seasonal pattern, although cases may increase in summer and fall.[4]

Figure 2. Pertussis: Virginia, 1997-2002*, Cases by Age



**2002 data are provisional.*

Clinical Disease

Classic pertussis is characterized by three stages: catarrhal, paroxysmal and convalescent. Following an incubation period of 7-10 days (range, 4-21), the patient experiences symptoms most like the common cold: runny nose, sneezing, low-grade fever, and mild, nonproductive cough. The cough gradually becomes more severe and after 1-2 weeks the next stage begins.

The cough develops and intensifies into severe paroxysms of numerous rapid coughs. This is the result of toxins produced by the organism paralyzing the cilia and causing inflammation of the respiratory tract. A long inspiratory effort at the end of a paroxysm is usually accompanied by the characteristic high pitched whoop. Vomiting and exhaustion may follow. These episodes tend to occur more frequently at night. Pertussis often is first suspected during this paroxysmal stage. This stage is the longest and can last from 1-6 weeks, but may persist up to 10 weeks. Most of the major complications of pertussis occur during the escalating phase of this stage. Secondary bacterial pneumonia is the most common complication and the cause of most pertussis-related deaths. Neurologic complications such as seizures and encephalopathy are more common among infants.

Recovery is gradual during the convalescent phase. The cough becomes less severe and paroxysmal and typically disappears over 2-3 weeks, although this may take months. Paroxysms frequently recur with subsequent respiratory infections.

Classic, severe pertussis has been defined in many ways. The World Health Organization describes it as at least 21 days of cough illness with paroxysms, associated whoops or post-tussive vomiting, and culture confirmation.

A broader definition is recommended by the CDC: a 14-day illness with paroxysmal cough, whoop, or post-tussive vomiting, confirmed by either culture or PCR. Laboratory-confirmed illness that does not meet the clinical criteria is considered mild. Mild disease likely occurs in all age groups beyond very early infancy, including children. Older persons (adolescents and adults) and those partially protected by the vaccine often have milder disease and may be undiagnosed. They may present with persistent cough indistinguishable from other upper respiratory infections; whoop is uncommon. These people may transmit disease to other susceptible individuals, including unimmunized or under immunized infants. Individuals with waning immunity who become infected appear to play an important role in transmitting infection. Thus, controlling mild illness may be a necessary step in preventing severe disease.

Laboratory Diagnosis

Culture remains the gold standard for diagnosis, but the organism has fastidious growth requirements. Isolation is most successful when direct inoculation to selective media is used during early illness. Beyond the first three weeks of illness, bacterial numbers diminish and it is difficult to isolate the organism or detect its antigens.

Table 1. Number of Pertussis Cases, 1997- 2002, by Age and Hospitalization Status

	0-6 mo		7-11 mo		1-4 yrs		5-9 yrs		10-18 yrs		>18 yrs		Unknown		All Ages	
YEAR	cases	hosp.	cases	hosp.	cases	hosp.	cases	hosp.	cases	hosp.	cases	hosp.	cases	hosp.	cases	hosp.
1997	19	14	2	1	9	3	11	3	9	0	9	2	0	0	59	23
1998	17	14	1	0	4	0	4	1	22	1	6	0	2	0	56	16
1999	10	7	1	1	5	1	8	0	21	2	19	1	1	0	65	12
2000	37	23	4	0	14	0	31	0	31	1	17	1	0	0	134	25
2001	25	14	2	0	23	0	34	1	115	2	73	2	0	0	272	19
2002 *(provisional)*	45	30	1	0	15	1	11	0	62	1	25	1	1	0	160	33
TOTAL	**153**	**102**	**11**	**2**	**70**	**5**	**99**	**5**	**260**	**7**	**149**	**7**	**4**	**0**	**746**	**128**
% of All Cases	20.5		1.5		9.4		13.3		34.9		20.0		0.5		100	
% of Age Group Hospitalized	66.7		18.2		7.1		5.1		2.7		4.7		0.0		17.2	
% of All Hospitalizations	79.7		1.6		3.9		3.9		5.5		5.5					

Direct fluorescent antibody (DFA) techniques can be used to detect bacterial antigens in nasopharyngeal secretions. However, DFA has demonstrated low sensitivity and variable specificity. It should not be relied upon as a criterion for laboratory confirmation.

PCR testing is a rapid, highly sensitive, highly specific method that can detect the presence of bacterial DNA even when appropriate therapy has been given. PCR can remain positive for an additional week after antibiotics have been started. It must be noted that a positive PCR without appropriate clinical symptoms is not considered a case of pertussis. CDC recommends that PCR be used in addition to culture and not as a substitute.

The best sample for the above tests is nasopharyngeal secretions obtained by aspiration and/or wash. Aspirates or washes are preferred over swabs as more material is obtained. Swabs, if used, should be placed into the posterior nasopharynx for 45 seconds. It is important to sample both nares as often only one side will be positive. Throat or sputum specimens are unacceptable since *B. pertussis* binds specifically to ciliated epithelial cells, found in the nasopharynx but not the mouth or throat. Cotton swabs should never be used for cultures since they contain toxic substances that kill the organism.

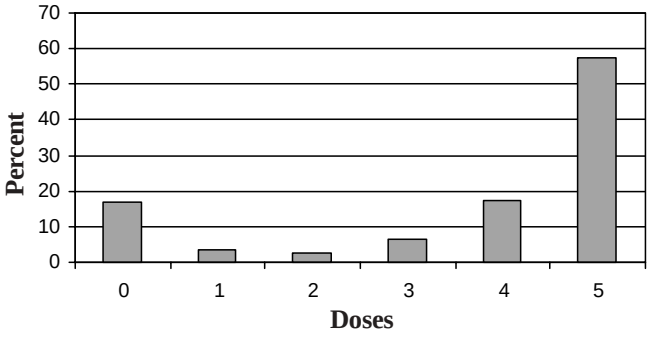
Testing for antibodies to various *B. pertussis* components is also available. These tests have proven useful in clinical studies but are not yet standardized. Results are difficult to interpret in immunized or partially immunized individuals and no single serologic test is diagnostic. IgG and/or IgA antibody measurements appear to be the most useful.[5] Cases that meet the clinical definition for pertussis that are serologically positive but are not culture or PCR positive are reported as probable cases.

Treatment of Cases

All patients with suspected or confirmed pertussis should receive antibiotic therapy. Treatment may not shorten the paroxysmal stage since this is a result of toxin production. However, it will decrease infectivity and may diminish morbidity and mortality due to secondary infections. If begun during the catarrhal stage, therapy will most likely reduce symptoms and halt multiplication of the organism. The patient should be excluded from work/school for the first 5 days of treatment. If treatment is refused, exclusion should be for 21 days from onset of symptoms.

Erythromycin (40-50 mg/kg/day orally in four divided doses; maximum, 2 g/day) is the standard treatment and should be continued for 10-14 days. Trimethoprim (T)-sulfamethoxazole (S) (8 mg/kg/day (T) and 40 mg/kg/day (S) BID in children and 320 mg/day (T) and 1600 mg/day (S) BID for adults for 14 days) is recommended as an alternative for those who cannot tolerate erythromycin, but efficacy is unproven. Although clinical data are limited, there is good evidence to suggest that macrolides such as clarithromycin (15-20 mg/kg/day orally in two divided doses; maximum 1 g/day, for 10-14 days) and azithromycin (10-12 mg/kg/day orally in one dose; maximum 500 mg/day, for 5-7 days) are also effective.

Figure 3. Doses of Pertussis-Containing Vaccine Received,* Pertussis Cases, 1997-2002**



**Of those with known immunization status and >6 mo of age.*
***2002 data are provisional.*

Initiating treatment more than 3 weeks after cough onset has limited benefit to the patient or contacts except in high risk cases (e.g., immunosuppressed individuals, infants <1 year old, persons who may expose those at high risk for severe disease).

Treatment of Contacts

Erythromycin should be administered for 10-14 days to all household and other close contacts of patients with pertussis, regardless of age and vaccination status. The other drugs listed above for treatment of cases also may be used for prophylaxis of contacts. Children <7 years who have not completed the primary vaccination series should do so using minimum intervals. A booster dose should be given to children <7 years who have completed the primary series but have not received immunization within 3 years of exposure.

To ensure uniformity throughout the state, the Virginia Department of Health has developed the following definitions of close contact:

- Direct face-to-face contact ≥1 hour total/week with a case-patient who is symptomatic (e.g., boyfriend/girlfriend, close friends, babysitters and the children they care for);
- Shared confined space in close proximity for at least 10 hours/week with a symptomatic case-patient (e.g., household contacts, sport teams, bus or carpool contacts, worksite, church, social contacts); or
- Direct contact with respiratory, oral, or nasal secretions from a symptomatic case-patient (e.g., explosive cough or sneeze in the face; sharing food, eating utensils, lip gloss, cigarettes, etc.; or performing a full medical exam including examination of the nose and throat).

Asymptomatic contacts do not have to be excluded from work or school. Contacts whose last exposure occurred ≥21 days ago do not routinely need to be treated. High risk contacts should be considered for treatment up to 6 weeks after exposure (e.g., infants <1 year of age, persons with immunosuppression or chronic diseases).

Erythromycin use in infants <4 weeks of age should be carefully considered. An increased incidence of pyloric stenosis has been observed among babies receiving it for chemoprophylaxis. CDC recommends only close observation of infants <4 weeks of age unless or until the infant becomes symptomatic. Should an infant become symptomatic, treatment should be initiated with caution.

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Cases of Selected Notifiable Diseases Reported in Virginia*

Disease	Total Cases Reported, November 2002: State	Regions: NW	N	SW	C	E	Total Cases Reported Statewide, January through November: This Year	Last Year	5 Yr Avg
AIDS	90	3	68	6	3	10	732	878	861
Campylobacteriosis	77	23	17	14	12	11	580	484	561
***E. coli* O157:H7**	7	1	1	2	2	1	62	48	68
Giardiasis	52	8	21	9	6	8	306	348	401
Gonorrhea	941	47	74	146	235	439	9741	9685	8877
Hepatitis A	17	1	1	1	5	9	140	122	168
B, acute	24	3	0	5	9	7	186	163	122
C/NANB, acute	5	0	0	1	4	0	15	0	10
HIV Infection	90	3	32	4	37	14	856	884	798
Lead in Children†	65	9	12	7	17	20	780	621	630
Legionellosis	10	5	0	2	1	2	30	21	26
Lyme Disease	13	3	2	2	2	4	147	115	99
Measles	0	0	0	0	0	0	0	1	5
Meningococcal Infection	4	1	0	1	0	2	40	37	45
Mumps	1	0	0	0	1	0	4	8	11
Pertussis	9	4	0	1	2	2	133	40	57
Rabies in Animals	50	17	12	9	8	4	554	449	537
Rocky Mountain Spotted Fever	8	0	0	2	4	2	42	26	17
Rubella	0	0	0	0	0	0	0	0	<1
Salmonellosis	152	26	48	25	25	28	1172	1211	1062
Shigellosis	114	5	14	2	33	60	927	389	306
Syphilis, Early§	11	0	2	1	1	7	153	228	353
Tuberculosis	22	0	12	2	5	3	251	258	273

Localities Reporting Animal Rabies This Month: Albemarle 2 raccoons; Amherst 1 skunk; Appomattox 2 skunks; Arlington 1 raccoon; Augusta 1 skunk; Buckingham 1 raccoon; Buena Vista 1 dog; Campbell 1 skunk; Charlotte 1 skunk; Clarke 2 raccoons, 1 skunk; Culpeper 1 skunk; Cumberland 1 skunk; Fairfax 6 raccoons; Fauquier 1 raccoon; Floyd 1 skunk; Fluvanna 1 bobcat; Frederick 1 bat; Giles 1 bobcat; Hanover 2 skunks; Henry 1 raccoon; Loudoun 2 raccoons; Louisa 1 fox, 1 raccoon; Lynchburg 1 skunk; Norfolk 2 raccoons; Northampton 1 raccoon; Orange 1 cat; Patrick 1 raccoon; Prince Edward 1 raccoon; Prince George 1 skunk; Prince William 1 cat, 1 fox, 1 raccoon; Shenandoah 1 skunk; Stafford 1 raccoon; Surry 1 skunk; Warren 1 skunk; Westmoreland 1 raccoon.

*Data for 2002 are provisional. †Elevated blood lead levels ≥10µg/dL.

§Includes primary, secondary, and early latent.

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