The Increasing Incidence of Pertussis in Massachusetts Adolescents and Adults, 1989–1998

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From 1989 to 1998, the incidence of pertussis increased in Massachusetts adolescents and adults, reaching 71 and 5 per 100,000, respectively, by 1998, whereas the incidence in children remained stable. By 1998, 92% of cases occurred in adolescents and adults. Nationally, in contrast, adolescents and adults had incidences of only 5 and 0.8 per 100,000, respectively, and accounted for 47% of cases. The availability of a specific serologic test and active surveillance by public health personnel in Massachusetts are at least partial explanations. The rise in incidence may be real, however, because, as diagnostic efforts increased, the percentage of patients with a positive serologic test result also increased. Cases identified in adolescents and adults were quite severe: 83% and 87%, respectively, experienced paroxysmal cough, 45% and 41% experienced vomiting, and 41% and 52% experienced a cough lasting >4 weeks.

Administration of acellular pertussis vaccine in these age groups could prevent this substantial morbidity.

The incidence of reported pertussis in the United States, which had declined sharply since whole-cell pertussis vaccines came into general use in the mid-1940s, has risen 3-fold since the early 1980s, from 0.75 per 100,000 in 1980 to 2.74 in 1998. Adolescents and adults, in whom the reported incidence of pertussis grew by more than an order of magnitude over the same period, contributed greatly to this increase. The proportion of all reported cases that occurred in persons >10 years of age rose from 13% in 1980 to 47% in 1998 (Centers for Disease Control and Prevention [CDC], unpublished data).

There are several possible explanations for these trends:

1. Decline in population immunity. Immunity from immunization is known to wane in the decade following the last pertussis vaccine dose [1, 2], which is administered before age 7 years. In contrast, immunity from natural infection may last longer than vaccine-induced immunity. As the number of those who had pertussis in the prevaccine era progressively decreases, the proportion of susceptible adolescents and adults grows [3–5].

2. Improvements in diagnosis and surveillance. Another possibility is that immunity from infection is not long lasting and that pertussis in adolescents and adults has been endemic and largely unrecognized. The observed increase in incidence in adolescents and adults may then be due to heightened awareness of the disease in these age groups and improvements in diagnostic methods [6, 7].

3. Genetic change in *Bordetella pertussis*. A third possibility is that circulating pertussis strains have diverged genetically from the strains used to make whole-cell vaccines [8, 9]. If such genetic divergence is associated with antigenic changes, this could progressively shorten the duration of vaccine-induced immunity and increase incidence, at least in adolescents.

Whatever the explanation for the observed increases, there appears to be a widely held view that the incidence of pertussis in adolescents and adults is higher than reported. This view is supported by a variety of studies:

1. Serologic surveys of selected groups of adolescents or adults have found substantial evidence of previous pertussis infection, although these studies have not determined how often infection is symptomatic [10–12].

2. Serologic testing of patients with persistent cough has established that pertussis is often the cause [13–16].

3. Serologic methods have been used to estimate the incidence of pertussis disease in defined populations [17, 18]. There are, however, no studies of populations in defined...
geographic regions that use specified diagnostic and case ascertainment methods to determine the burden of symptomatic pertussis disease.

In Massachusetts, the Department of Public Health (MDPH) engages in extensive and intensive pertussis surveillance and provides pertussis diagnostic services. Because these systems have been in place for more than a decade, Massachusetts may offer a more complete picture of recent trends in pertussis incidence among adolescents and adults than has been attained in other highly immunized populations. In this study, we examine the epidemiology of pertussis in Massachusetts in the period 1989–1998 and consider the question of whether the observed trends can be explained by changes in diagnostic and surveillance practices alone.

Subjects and Methods

Diagnostic methods. The Massachusetts State Laboratory Institute (MA SLI) of the MDPH provided free pertussis diagnostic testing services that included culture of nasopharyngeal secretions for B. pertussis and serodiagnosis. Since late 1987, the MA SLI has performed a single-serum ELISA for IgG to pertussis toxin (PT) in persons ≥11 years of age. The specificity of this assay was set, using sera from uninfected persons, at >99%, by calculating the 99% upper tolerance limit. (This means that there is 95% statistical confidence that the antibody concentrations of 99% of the uninfected population are below this limit.) The 99% upper tolerance level for the assay is a concentration of 20 μg/mL [19]. In persons ≥11 years of age with pertussis confirmed by culture, the sensitivity of this single-serum assay was 67% (95% confidence interval [CI], 53%–81%) for those with a cough of ≥2 weeks’ duration and 36% (95% CI, 20%–52%) for those with a cough duration <2 weeks. Thus, this single-serum anti-PT antibody assay, when positive, is an excellent test for confirming the diagnosis but, when negative, is a poor test for excluding pertussis as a cause of a coughing illness. Only serology performed at the MA SLI has ever been accepted by the MDPH as diagnostic. During 1989–1998, a few changes were instituted:

1. Effective 1 October 1995, the MA SLI stopped testing both culture and serologic specimens from the same patient, in light of the fact that culture is most sensitive within 2 weeks of cough onset and serology most sensitive beyond 2 weeks of cough onset. A memorandum to health care providers in the summer of 1995 announcing this change explained that, for persons ≥11 years of age, if cough duration was ≤2 weeks, a culture should be submitted, and, if ≥2 weeks, serum should be submitted.

2. Beginning in mid-1996, on the basis of a report by Katzko et al. [20], the MA SLI began extending the period of incubation of culture plates from 7 to 12 days, to improve recovery.

3. In December 1996, because of unprecedented numbers of cases and of specimens being submitted, epidemiologists were instructed to discourage submission of specimens from outbreak settings that already had ≥3 serologically confirmed cases and ≥1 culture-confirmed case.

Case definition and case classification. Laboratory confirmation required at least one of the following: (1) Isolation of B. pertussis from a nasopharyngeal specimen (by any laboratory); (2) until mid-1992, positive direct fluorescent antibody staining of nasopharyngeal secretions, if performed by the MA SLI [19]; (3) a positive polymerase chain reaction (PCR) assay for B. pertussis; or (4), for persons ≥11 years of age, single-serum anti-PT levels of ≥20 μg/mL (by the assay described above). A case that was positive by culture and any other method was classified as culture confirmed. An epidemiologically linked case was defined as occurring in a person with clinical symptoms of pertussis (i.e., a case that fulfilled the clinical case definition) who had known contact with a person with a laboratory-confirmed case.

The case definition of pertussis changed just once over the period 1989–1998, toward greater specificity. Throughout the 10-year period, a case of acute cough of any duration that was culture positive constituted a confirmed case. From 1989 to 1992, a case of acute cough lasting ≥1 week and accompanied by paroxysms or posttussive vomiting, which was either laboratory confirmed or epidemiologically linked to a laboratory-confirmed case, was also considered a pertussis case [21]. From 1993 to 1998, the MDPH adopted the CDC clinical case definition [22] for serologically confirmed, PCR-confirmed, and epidemiologically linked cases: a cough illness lasting ≥2 weeks, with paroxysms of coughing, inspiratory “whoop,” or posttussive vomiting.

Epidemiologic investigation and surveillance. Most initial case ascertainment began when MDPH epidemiologists received a positive culture or serology result from the MA SLI or, less often, a culture or PCR result from an outside laboratory. Throughout the period, the MDPH’s control efforts included rigorous, focused surveillance. Whenever a confirmed case was identified in a particular setting, MDPH epidemiologists, local boards of health, school nurses, and hospital infection control staff carried out intensive, institution-based surveillance. This included interviewing patients or their parents to determine transmission settings and close contacts, sending out letters alerting people in the affected institution to the presence of pertussis, conducting cough surveillance, and referring symptomatic individuals for diagnostic testing. When ≥1 laboratory-confirmed case and ≥5 total cases were found in a school or work setting, it was considered an outbreak.

Pertussis vaccines. From 1950 until 1996, the MDPH Biologic Laboratories manufactured whole-cell diphtheria-tetanus-pertussis (DTP) vaccine, as described elsewhere [19], which was distributed free to physicians, clinics, and hospitals throughout the state. This vaccine met the same US Food and Drug Administration (FDA) potency tests as other vaccines licensed in the United States. Beginning in October 1996, the MDPH began distributing state-purchased diphtheria-tetanus–acellular pertussis vaccine (DTaP) to all providers in the state, again at no charge. The sole DTaP product distributed by the MDPH has been Tripedia (Aventis Pasteur, Swiftwater, PA); the pertussis component contains inactivated pertussis toxin and filamentous hemagglutinin.

Immunization surveys. Pertussis vaccine coverage in Massachusetts was assessed by determining the proportions of Massachusetts 2-year-olds and kindergartners who had received ≥4 doses of DTP/DTaP. These proportions were estimated by 3 methods: (1) review of immunization levels of 2-year-olds by means of an annual survey of a sample of Massachusetts kindergartners’ re-
Figure 1 shows incidence trends for each of the 4 age groups (<1, 1–10, 11–19, and ≥20 years) over the period 1989–1998.

**Results**

**Pertussis incidence.** The crude incidence of pertussis in Massachusetts increased from 3.2 per 100,000 in 1989 to 12.8 per 100,000 in 1998 (P < .001). When the 1996 incidence (an anomalous year with 20 cases per 100,000) was omitted from trend analysis, the trend still remained highly significant (P < .001).

Figure 1 shows incidence trends for each of the 4 age groups (<1, 1–10, 11–19, and ≥20 years) over the period 1989–1998. In infants, incidence of reported pertussis varied from a low of 31 (in 1994) to a high of 99 (in 1996) per 100,000 but did not increase during that decade (P = .69). Incidence in children 1–10 years of age was much lower (3–7 cases per 100,000) and, similarly, displayed no trend over the 1989–1998 period (P = .28). In contrast, incidence in adolescents (ranging from 13 per 100,000 in 1989 to 121 per 100,000 in 1996) rose markedly (P < .001). Incidence in adults, although much lower than that in adolescents (0.4–6 per 100,000), also increased significantly (P < .001). The upward trends in incidence for adolescents and adults were significant, at P < .001, even when 1996 was omitted from the analyses.

During the teenage years, the age-specific incidence increased from 28 cases per 100,000 person-years in 11-year-olds to a peak of 78 cases per 100,000 at age 15, then declined to 20 per 100,000 in 18-year-olds. In adults, incidence decreased with increasing age to a low of <0.5 per 100,000 in the ninth decade of life, although the highest incidence—4.5 per 100,000—occurred in the fifth decade.

**Pertussis incidence in adolescents and adults by diagnostic method.** The relative proportions of cases confirmed by culture, serology, and epidemiologic linkage differed by age group and varied over time. Most adolescent and adult cases were confirmed by MA SLI serology (figure 2). The proportion of cases confirmed by this method increased between 1987 (the year the test was introduced) and 1998, and by 1998 it had reached 77% for adolescents and 86% for adults.

**Age distribution.** The percentage of total pertussis cases that occurred in adolescents ranged from 39.5% to 69.7%, and that in adults ranged from 10.3% to 29.0%. The percentage of cases in adolescents and adults combined rose during the 10-year period to a high of 92.3% in 1998.

**Sex.** Incidence of pertussis was slightly higher for females than for males—8.8 and 8.1 per 100,000 population, respectively (P < .01). Incidences (cases per 100,000 population) for females and males, respectively, were 56.1 and 55.2 for infants; 5.7 and 5.0 for children 1–10 years of age; 49.0 and 44.2 for adolescents 11–19 years of age; and 2.9 and 2.0 for adults ≥20 years. The
ratio of female incidence to male incidence was greater in adults (1.45) than in the younger age groups (1.01–1.14).

Immunization rates. The retrospective survey of kindergartners and the NIS yielded similar results on the proportion of Massachusetts 2-year-olds having received $\geq 4$ doses of DTP/DTaP for the 2 years in which there was overlap. The proportion rose steadily, from 73% of 2-year-olds born in 1983 to 91% of 2-year-olds born in 1996. Similarly, results from school entry surveys showed that the proportion of Massachusetts kindergartners having received $\geq 4$ doses of DTP/DTaP increased from 88% in 1975 to 98% in 1998.

Although Massachusetts requires that children receive 5 doses of pertussis vaccine before school entry, there are no surveys of pertussis immunization rates in students beyond kindergarten. The immunization history of persons with pertussis, however, is routinely investigated. Among the 2579 reported adolescent pertussis patients with cough onsets in 1989–1998 whose immunization history was known, 2354 (91%) had received $\geq 4$ doses of DTP (1686 [65%] had received $\geq 5$ doses), and 225 (9%) had received $<4$ doses. In 531 adolescents (17% of the 3110 total adolescent patients), the immunization status was not reported. Immunization histories of adults with pertussis are not known with accuracy.

Clinical characteristics. Symptoms at the time of diagnosis were recorded in a systematic fashion by MDPH epidemiologists, but once antimicrobial therapy was instituted, follow-up
was carried out by health-care providers, and there was no uniform investigation of patients to assess their symptoms over the entire course of disease (except to determine whether cases ultimately fulfilled the clinical case definition). Clinical characteristics reported are thus the minimum extent and duration of symptoms in pertussis patients.

Among cases in adolescents and adults, 83% and 87%, respectively, had paroxysmal coughing, and many had whooping, apnea, and vomiting at the time of diagnosis (table 1; “time of diagnosis” was the day a specimen was collected for diagnostic testing). Among laboratory-confirmed cases of pertussis, 41% of adolescents and 52% of adults had coughed >4 weeks at the time of diagnosis.

In 1.5% of culture-confirmed and 1.6% of serologically confirmed adolescent pertussis cases, patients were hospitalized; the mean number of visits to a doctor’s office per adolescent patient (across all diagnostic methods) by the time of diagnosis was 1.9. In adults, the proportions of patients hospitalized were higher than for adolescents: 6.6% of culture-confirmed cases and 3.5% of serologically confirmed cases. The mean number of visits to a doctor’s office per adult patient (across all diagnostic methods) by the time of diagnosis was 2.2.

**Diagnostic effort and the proportion of specimens testing positive.** To determine the effects of diagnostic effort on the observed incidence of pertussis in Massachusetts, trends in the numbers of specimens received and in the percentage of specimens that were positive were examined.

**Culture.** The number of culture specimens submitted to the MA SLI increased between 1989 and 1998. Over the period 1993 (the earliest year for which submissions were tracked by age) to 1998, in adolescents, there was an increase in the number of specimens submitted (of 107 additional specimens per year) and a linear trend \( P < .001 \) upward in percent positive (1.1 percentage points per year). In adults, the number of specimens increased (by an estimated 55 additional specimens per year), with no apparent trend in percent positive. In contrast, for infants, there was little systematic change in number of specimens submitted and a slight linear trend \( P = .04 \) downward in percent positive (an estimated \(-0.5\) percentage points per year), whereas for children, the number of specimens increased (by 62 additional specimens per year), and there was a slight linear trend \( P < .005 \) downward in percent positive (\(-0.7\) percentage points per year).

**Serology.** Both the number of serology specimens submitted to the MA SLI and the percentage of serology specimens testing positive increased between 1992 (the earliest year for which data are available) and 1998. The increase in serology specimens submitted was estimated at 408 per year. The proportion of total serology specimens testing positive over the period 1992–1998 increased an estimated 1.4 percentage points per year \( P < .001 \). No age-specific analysis of these trends is possible, because serology submissions have been tracked by age only since mid-1997.

**Trends in disease severity at the time of diagnosis.** During the 10-year period, the severity of symptoms at the time of diagnosis in serologically confirmed cases decreased, which suggests that clinicians were increasingly suspicious of pertussis in coughing adolescents and adults. The proportions of adolescents and adults coughing >4 weeks at the time of diagnosis decreased \( P < .001 \) for both, dropping from 76% to 43% for adolescents and from 74% to 56% for adults. The proportions of adolescents reporting paroxysms, whoop, and posttussive vomiting at the time of diagnosis likewise decreased, from 95%, 53%, and 74%, respectively, in 1989 to 84%, 31%, and 49%, respectively, in 1998 \( P < .01, P < .001, \) and \( P < .001, \) respectively. In contrast, the proportions of adults reporting each of these 3 symptoms did not change in a systematic direction.

**Seasonal variation.** Across the 10-year period, for both adolescents and adults, the numbers of pertussis cases typically reached a peak in either the third or fourth quarter of the year. In 7 of the 10 years, the peak pertussis activity in adolescents was in the fourth quarter.

### Table 1. Clinical characteristics of adolescent and adult patients at time of pertussis case diagnosis, by age group and method of diagnosis, 1989–1998.

<table>
<thead>
<tr>
<th>Clinical characteristic</th>
<th>By age group</th>
<th>By diagnostic method</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Adolescents</td>
<td>Adults</td>
</tr>
<tr>
<td></td>
<td>Culture</td>
<td>Serology</td>
</tr>
<tr>
<td>Paroxysms</td>
<td>2512 (83)</td>
<td>960 (87)</td>
</tr>
<tr>
<td>Whoop</td>
<td>914 (30)</td>
<td>381 (35)</td>
</tr>
<tr>
<td>Apnea</td>
<td>588 (19)</td>
<td>403 (37)</td>
</tr>
<tr>
<td>Cyanosis</td>
<td>174 (6)</td>
<td>94 (9)</td>
</tr>
<tr>
<td>Vomiting</td>
<td>1371 (45)</td>
<td>447 (41)</td>
</tr>
<tr>
<td>Hospitalized</td>
<td>41 (1.4)</td>
<td>39 (3.5)</td>
</tr>
<tr>
<td>( N ) for symptoms*</td>
<td>3023–3037</td>
<td>1099–1103</td>
</tr>
<tr>
<td>Cough ( &gt;4 ) weeks</td>
<td>987 (41)</td>
<td>451 (52)</td>
</tr>
<tr>
<td>( N ) for cough duration*</td>
<td>2384</td>
<td>871</td>
</tr>
</tbody>
</table>

NOTE. Values are no. (%), unless indicated otherwise. Epi, epidemiologically.

* The number of cases used to calculate percentages varied by clinical characteristic because of missing data on some clinical characteristics (especially cough duration) for some cases.

* Duration of cough for epidemiologically linked cases is not presented, because timing of interviews of such case-patients was highly variable and was dependent on factors extrinsic to the course of illness in these individuals.
Discussion

Pertussis in adults and adolescents is not a new or localized phenomenon but has been documented for many years and in many countries [13, 14, 18, 24]. Pertussis in adults and adolescents, however, has traditionally been a small fraction of reported cases in both unimmunized and highly immunized populations. Since the waning immunity after immunization with pertussis vaccine in childhood was documented >3 decades ago [1], it would have been reasonable to expect increased reporting of pertussis in adolescents and adults. The incidence remained low, however, presumably because pertussis was rarely considered as a cause of coughing illnesses in these age groups, or perhaps because of a lack of appropriate diagnostic methods. In recent years, however, there has been a slow and steady increase in incidence in the United States [25].

Over the past decade, we documented an increasing incidence of pertussis in Massachusetts adolescents and adults, whereas the incidence in infants and children remained stable, and immunization rates, already high, increased even further. From 1989 to 1998, Massachusetts accounted for 23% of cases of pertussis in persons >10 years of age in the United States, yet the state constitutes only 2% of the national population. The contrast between Massachusetts and the United States as a whole, with respect to both reported incidence of pertussis in adolescents and adults and the proportion of cases occurring in these age groups, is striking. In 1998, incidence in the United States as a whole was 56.5 per 100,000 in infants, 4.9 in children (1–9 years of age), 5.0 in adolescents (10–19 years of age), and 0.82 in adults (>20 years of age; CDC, unpublished data), whereas Massachusetts saw incidences of 50.9 per 100,000 in infants, 2.5 in children (1–10 years of age), 70.9 in adolescents (11–19 years of age), and 5.0 in adults (>20 years of age). In each of the 5 years from 1994 to 1998, at least half of all reported Massachusetts cases occurred in adolescents, compared with 22% in the United States as a whole in 1994–1996 [25]. In 4 of the 5 years between 1994 and 1998, close to 90% of Massachusetts cases occurred in adolescents and adults combined (>11 years), compared with a proportion of only 38% in the United States in 1994–1996 [25]. Although the relatively high immunization levels in Massachusetts may explain the lower incidences in children, the 14- and 6-fold higher incidences in Massachusetts adolescents and adults, respectively, and the much higher proportions of total cases in these groups, compared with those in the United States as a whole, require some explanation.

Massachusetts differs from most states in that it manufactured its own whole-cell DTP vaccine. Although no direct data are available to compare the efficacy of the licensed whole-cell vaccine used in Massachusetts with the efficacy of those used in the rest of the United States, all of these vaccines met the same FDA standards and lot release testing requirements. More importantly, the Massachusetts vaccine has protected infants and children in Massachusetts for decades, as shown by the low incidence of pertussis in Massachusetts infants and children compared with that in United States as a whole (data cited above). Moreover, serologic data from Tennessee documented an increasing pertussis attack rate in adolescence with a peak in mid-adolescence, a pattern consistent with waning immunity from childhood immunization and pertussis infection among adolescents [26]. Massachusetts incidence data show the same the age-specific increase in pertussis, with a peak at age 15 years. If protection from pertussis immunization were less effective in Massachusetts, then the peak of pertussis activity should have occurred at a younger age. Thus, the argument that the high incidence of pertussis in adolescents and adults in Massachusetts is related to the quality of the Massachusetts vaccine is not compelling.

Two more plausible reasons for both the US-Massachusetts differences and the increases are (1) the use of the single-serum anti–pertussis toxin antibody assay for pertussis diagnosis in people >11 years of age and (2) intensive active surveillance for pertussis in Massachusetts, particularly the investigation of school outbreaks. The use of serologic diagnosis is the most obvious explanation. Because the single-serum anti–PT antibody test can detect B. pertussis infection in persons with symptoms that have lasted >2 weeks, a period when the sensitivity of culture of the nasopharynx is declining [27], its use has led to a substantial increase in proven pertussis cases. Submission of specimens has grown, and serology has been the method of confirmation for an increasing proportion of cases in both adolescents and adults. Another highly specific ELISA for IgG-PT in a single serum, validated in a large population-based study in The Netherlands, was recently described [28].

Intensive surveillance of possible contacts after laboratory confirmation of a case has also led to progressively better case ascertainment. When pertussis was found in a school, for example, school health personnel identified and followed contacts, conducted cough surveillance, and referred symptomatic students and staff for testing, leading to increased case discovery. This intensive surveillance, combined with the possibility that adolescent social behavior favors transmission, may contribute to the high proportion of outbreaks observed to occur in schools.

Serologic testing and increased surveillance have uncovered more cases of pertussis in adolescents and adults, but are there more cases to be detected with further effort, and is the incidence actually increasing? To address these questions, we examined the relationship between diagnostic effort and the yield of pertussis cases generated by this effort. If pertussis incidence is low and not increasing, increased diagnostic effort should lead to a diminishing number of cases with each increment of increased diagnostic effort. On the other hand, if pertussis incidence is, in fact, high or increasing, increased diagnostic efforts may not result in a decline in the number of cases discovered for each increment of diagnostic effort.

Although our data do not allow us to separate the number
of serology specimens submitted in adolescents versus adults, the number of specimens submitted increased in these 2 age groups combined during the decade, and the percentage of specimens testing positive also increased. If pertussis surveillance in Massachusetts were approaching complete ascertainment, the percentage of specimens testing positive would have declined with increased testing. Furthermore, the decline in cough duration at diagnosis and in case severity (at least in adolescents) at the time of diagnosis suggests that diagnostic suspicion has increased also. If, in fact, clinicians became progressively less stringent in the clinical symptoms they required before diagnostic testing, one would expect the percentage of positive specimens to decline, but the opposite has happened. Although surveillance data do not allow us to conclude with certainty that there has been a real increase in incidence of pertussis in adolescents and adults, at the very least, our data demonstrate that we have not yet determined the full extent of pertussis in these age groups. We expect that, if diagnostic testing and surveillance efforts are increased in other geographic areas, a substantial incidence of adolescent and adult pertussis will similarly be uncovered.

The preponderance of cases in adolescents, typically 50%–66% of all reported cases, appears to dominate the observed seasonal pattern of pertussis, producing the often pronounced peak in October–December, a pattern likely enhanced (or possibly even caused) by intensified transmission as school and associated sports activities get under way [29]. Nationwide, in the period 1990–1996, cases in 5–19-year-olds (school-age children, analyzed as a single combined group) also peaked in October–December [25]. The lack of a clear seasonal pattern in Massachusetts infant cases accords with findings from other regions of the United States [30, 31], although we did note a consistent and marked increase in infant cases between the second and third quarters.

Although, in some instances [24, 32, 33], pertussis is a mild disease in adolescents and adults, our surveillance system rarely detected cases with mild upper respiratory tract symptoms, but rather cases with prolonged paroxysmal coughing, often with whoop and posttussive vomiting. Furthermore, because total symptom duration was not systematically determined, morbidity may be even greater than we report. Also, pertussis in adolescents and adults has an impact on health care services. In 1% of culture-confirmed adolescent cases and 7% of culture-confirmed adult cases, the patients had been hospitalized by the time of diagnosis, and both age groups averaged ~2 physician visits per case by the time of diagnosis.

In conclusion, Massachusetts has experienced a significant increase in incidence of reported pertussis in adolescents and adults over the period 1989–1998, during which time incidence in infants and children <11 years of age has not increased. The incidence and proportion of cases in adolescents and adults are considerably higher than in the United States as a whole, with incidence in adolescents exceeding the national incidence in adolescents by a factor of 14. The availability of a specific serology test and intensive surveillance by trained school health personnel and epidemiologists at the state health department partially explain these findings. A relatively high proportion of total reported cases has been associated with school-based outbreaks in recent years, which may result from focused surveillance in schools, enhanced transmission, or a combination of these. Changes in diagnostic and surveillance practices may not be the only factors responsible for the steep increase in incidence in adolescents. An increase in the percentage of serology specimens and of adolescent culture specimens testing positive suggests that additional factors are involved. In any event, it is clear that the incidence of pertussis, as well as the severity of disease, in adolescents and adults is much greater than is generally reported and that administration of acellular pertussis vaccine in these age groups could prevent substantial morbidity and possibly reduce pertussis transmission.

References