Community Outbreak of *Mycoplasma pneumoniae* Infection: School-Based Cluster of Neurologic Disease Associated with Household Transmission of Respiratory Illness

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**Background.** We investigated an outbreak of severe neurologic disease and pneumonia that occurred among students at 4 schools in Rhode Island.

**Methods.** We identified cases of encephalitis, encephalomyelitis, and pneumonia that occurred among schoolchildren from 1 September 2006 through 9 February 2007, and we performed serologic tests, polymerase chain reaction (PCR) analysis, and culture for the detection of multiple pathogens in oropharyngeal and nasopharyngeal specimens. Students with positive results of *M. pneumoniae* IgM serologic testing and no alternative diagnosis were considered to be infected with *M. pneumoniae*. At school A, we used questionnaires to identify students and their household contacts who made visits to physicians for pneumonia and cough. We compared observed and expected rates of pneumonia.

**Results.** Rates of pneumonia among elementary students (122 cases/1000 student-years) were >5-fold higher than expected. Three students had encephalitis or encephalomyelitis, and 76 had pneumonia. Of these 2 groups of students, 2 (66%) and 57 students (75%), respectively, had *M. pneumoniae* infection. *M. pneumoniae* was detected by PCR in 10 students with pneumonia; 5 of these specimens were cultured, and *M. pneumoniae* was isolated in 4. Of 202 households of students attending school A, 20 (10%) accounted for 61% of visits to physicians for pneumonia or cough. Of 19 household contacts of students with pneumonia, 8 (42%) developed pneumonia and 6 (32%) reported visits for cough.

**Conclusions.** *M. pneumoniae* caused a community-wide outbreak of cough illness and pneumonia and was associated with the development of life-threatening neurologic disease. Although *M. pneumoniae* was detected in schools, its transmission in households amplified the outbreak. Interrupting household transmission should be a priority during future outbreaks.

*Mycoplasma pneumoniae* is a leading cause of respiratory infections among children and adults. The most common clinical syndromes associated with *M. pneumoniae* infection are acute bronchitis, pharyngitis, and otitis [1–3]. Approximately 10% of infected children and 2% of infected young adults develop pneumonia [1–3]. A small percentage of persons infected with *M. pneu-
moniae develop severe neurologic, hematologic, or dermatologic syndromes [4, 5].

Outbreaks of M. pneumoniae infection occur in congregate settings, such as hospitals [6–8], military installations [2, 9, 10], and residential schools and universities [11–14]. Longitudinal population-based serosurveys indicate that periods of increased incidence of M. pneumoniae infection occur approximately every 4–7 years [15–17]. However, outbreaks of M. pneumoniae infection in open community settings are uncommonly reported [18–26], and patterns of transmission noted during such outbreaks have not been described in detail in >30 years [27, 28]. Community outbreaks of M. pneumoniae infection are associated with considerable morbidity. However, because M. pneumoniae infection is infrequently confirmed by clinicians and is not required to be reported to public health officials, opportunities for outbreak detection are rare. We had the opportunity to examine these issues during an investigation of a community outbreak of M. pneumoniae infection in Rhode Island (RI).

In December 2006, physicians at the only pediatric referral hospital in RI informed the RI Department of Health of 3 children with encephalitis or acute disseminated encephalomyelitis (ADEM) thought to be due to M. pneumoniae infection diagnosed during a 2-week period in November–December. Two children, one of whom died, were second-grade classmates at school A; the third child attended middle school D in the same suburban area. When contacted, schools A and D reported high rates of pneumonia among students. In late November, an unusually high incidence of pneumonia also independently reported by nurses at 2 additional elementary schools (B and C) located within 5 miles of schools A and D. On the basis of preliminary evidence that the cluster of neurologic disease was due to M. pneumoniae, prophylactic azithromycin or doxycycline was distributed to 1200 students, staff, and household contacts at school A on 31 December 2006 and 1–2 January 2007. Subsequent, ultimately unverified reports of additional students with severe neurologic presentations led to a 2-day closure of schools serving ~20,000 children in 3 school districts. In early January, a statewide campaign promoting hand and cough hygiene was conducted, parents and guardians were urged to keep ill children home from school, and 20,000 alcohol-based hand-sanitizing gel dispensers were installed in all public and parochial schools in RI.

We performed an investigation to confirm that outbreaks were occurring at schools A–D, to determine the etiology of the outbreaks, and to characterize transmission within the school A community.

METHODS

Case finding. To identify cases of pneumonia among students at schools A–D, we distributed questionnaires to parents or guardians and reviewed the records of school nurses and the absentee logs. We abstracted physician records for all students with suspected pneumonia, to confirm the diagnosis. To identify cases of M. pneumoniae–associated neurologic and dermatologic disease, we conducted retrospective review and prospective surveillance from 1 November 2006 through 28 February 2007 at the only pediatric referral hospital in RI. We identified case patients who had neurologic or dermatologic disease, through consultation with infectious diseases and neurology physicians and through systematic review of the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) hospital discharge codes.

Definitions. The following definitions were applied to students at schools A–D during the outbreak period (1 September 2006 [1 week before the first reported onset of illness] through 9 February 2007 [1 month after implementation of control measures]). “Clinically confirmed pneumonia” was defined as an illness that a physician has diagnosed as pneumonia on the basis of the clinical impression. “Radiographically confirmed pneumonia” was additionally defined by documentation of radiographic findings consistent with pneumonia. For most children, the onset of illness occurred several weeks before the investigation began, precluding collection of acute-phase and convalescent-phase serum samples. Thus, for the purposes of the present investigation, “confirmed M. pneumoniae pneumonia” was defined as clinically or radiographically confirmed pneumonia for which the results of M. pneumoniae IgM serologic tests were positive. “Neurologic disease” was defined as an illness diagnosed as encephalitis or ADEM. “M. pneumoniae neurologic disease” was additionally defined by positive results of M. pneumoniae IgM serologic tests and no alternative diagnosis after extensive testing. “Severe M. pneumoniae dermatologic disease” was defined as an illness diagnosed as Stevens-Johnson syndrome in a student with positive results of M. pneumoniae IgM serologic tests. “Households” were defined as the primary residence of students. “Household contacts” were defined as persons currently residing in a student household who were not school A students.

Laboratory investigation. We collected serologic, oropharyngeal (OP), and nasopharyngeal (NP) specimens from case patients with neurologic or dermatologic disease and from the first 8 case patients who had pneumonia diagnosed. A Dacron-tipped swab (Puritan Medical Products) was passed over the mucosal surface of the posterior oropharynx (i.e., an OP swab) or through the nostril to the nasopharynx, rotated 180 degrees, and withdrawn (i.e., an NP swab). Specimens were transported in BD Universal Viral Transport System containers (Becton Dickinson) to the Centers for Disease Control and Prevention (CDC) for analysis. We performed real-time polymerase chain reaction (PCR) analyses on extracted total nucleic acid, to test for the presence of M. pneumoniae, Streptococcus pneumoniae, Staphylococcus aureus, Chlamydia pneumoniae, influenza A and
B viruses, respiratory syncytial virus, human metapneumovirus, human parainfluenza viruses 1–3, adenovirus, herpesvirus, and rhinovirus, as described elsewhere [29, 30]. Ten OP specimens that tested positive for *M. pneumoniae* by means of PCR underwent culture for *M. pneumoniae* as follows: 10-fold serial dilutions (from 10⁻¹ through 10⁻⁶) of swab specimens were performed on SP4 media [31]. The samples were incubated at 37°C, and blind passages of each tube were performed weekly for up to 6 weeks. Isolates were determined by observation of changes in the media color and were confirmed by PCR. Case patients with neurologic disease had additionally testing (PCR) performed for the detection of Epstein-Barr virus, herpes simplex viruses 1 and 2, varicella-zoster virus (in cerebral spinal fluid specimens), and enterovirus (in cerebral spinal fluid and stool specimens). After completion of this initial testing, subsequently identified case patients with pneumonia had OP specimens (for PCR analysis) and a single serum specimen (for IgM serologic testing) collected and tested only for *M. pneumoniae*. We tested serum samples with the use of 2 commercially available qualitative ELISAs: the Remel test (Remel), which detects the presence of *M. pneumoniae* IgG and/or IgM antibodies, and the Meridian test (ImmunoCard Mycoplasma; Meridian Bioscience), which detects only *M. pneumoniae* IgM antibodies.

**Epidemiologic investigation.** To confirm the presence of an outbreak of respiratory disease, we calculated the annualized rates of pneumonia per 1000 student-years and then compared observed and expected pneumonia incidence during September through February. Expected rates were established using month-specific data from the Group Health Cooperative (GHC), a large health maintenance organization in Washington State, because data on month- and age-specific pneumonia incidence were not available locally. The GHC provided 140,000 person-years of observation for elementary school- and middle school-aged children during 2002–2004. Diagnoses of pneumonia in the GHC data set are based on ICD-9-CM codes recorded in outpatient, emergency department, and hospital settings. We compared rates of pneumonia at elementary and middle schools with GHC-determined rates for children 5–10 years and 11–14 years of age, respectively.

Distribution of antibiotic prophylaxis at school A provided the opportunity to characterize transmission at that school and in the households of its students. At the time of antibiotic distribution, we asked all students at school A and their household contacts to provide OP and serum samples and to self-administer a questionnaire that included questions about pneumonia diagnoses as well as physician visits for cough occurring during the preceding 5 months. The date of the physician visit, rather than the date of symptom onset, was ascertained, to minimize recall bias. “Cough illness” was defined as an acute respiratory illness with cough as a presenting symptom. A “visit for cough” was defined as the first visit for cough illness made to a health care provider during the outbreak period by a person not subsequently given a diagnosis of pneumonia. Persons who made no visit for cough may have had cough but did not seek care. OP specimens were tested by PCR analysis, and serum specimens underwent serologic testing for the detection of *M. pneumoniae*. The completeness of the questionnaires was determined by comparing the total number of questionnaires completed by students with the total school enrollment, as well as by comparing the number of questionnaires completed by household contacts with the number of household contacts reported by parents.

To evaluate whether attendance at school A increased the risk of children developing pneumonia or cough illness, we compared the rate of occurrence of these conditions among students at school A with the rate among their siblings who were ≥12 years of age and did not attend school A. To account for the independent contributions of age and transmission within households, we used a multivariable conditional logistic regression model that included age, household, and student vs. non-student status, to calculate odds ratios (ORs) and 95% confidence intervals (95% CIs).

To describe household transmission, we defined “index case patients” as individuals who made a physician visit for pneumonia or cough ≥10 days before similar visits were made by any other household member. We also defined “secondary case patients” as household contacts who made a physician visit for pneumonia or cough ≥10 days after the visit made by the index case patient. Institutional review board approval was not required for this public health emergency response.

**RESULTS**

We identified 76 cases of pneumonia, 3 cases of neurologic disease, and 1 case of severe dermatologic disease among students at schools A–D during the 22-week outbreak period. Rates of pneumonia among children at elementary schools were >5-fold higher than expected during the period studied (122 vs. 22 cases/1000 student-years [range, 90–144 cases/1000 student-years at schools A–C]). At middle school D, the rate of pneumonia was >3 times higher than expected (41 vs. 12 cases/1000 student-years) (table 1).

Of the cases of pneumonia identified in students, 29 (38%) were radiographically confirmed, and 47 (62%) were clinically confirmed. Students with pneumonia experienced prolonged febrile illnesses with cough; 27 students (36%) were symptomatic for >7 days before diagnosis (range, 0–27 days). One student was hospitalized. Three peaks in pneumonia incidence were separated by approximately 4–6 weeks, which is consistent with the incubation period of *M. pneumoniae* infection (figure 1).

Serum samples were available from 60 of the 76 students with pneumonia; 40 (67%) and 57 (95%) of samples tested positive
by use of the Remel combined IgG/IgM assay and the Meridian IgM assay, respectively. The time between the onset of symptoms and etiologic testing ranged from 1 day to 3 months; 95% of case patients with pneumonia were tested >10 days after the onset of their symptoms. Overall, 57 case patients (75%) had a positive *M. pneumoniae* IgM result and were classified as having *M. pneumoniae* pneumonia. OP or NP specimens were available from 59 children with pneumonia; 10 specimens (17%) tested positive for *M. pneumoniae* by PCR. Specimens tested within 14 days of symptom onset were not more likely to have positive PCR results than were those tested later (1 of 7 and 9 of 52 specimens, respectively; *P* = .8). Five PCR-positive specimens were selected for culture; *M. pneumoniae* was isolated from 4 of these 5 specimens. Two of the first 8 case patients with diagnosed pneumonia who were reported to the Department of Health tested positive for rhinovirus, and 1 tested positive for adenovirus, by means of PCR. No other etiologies were identified for any of the children who underwent testing.

Table 1. Pneumonia incidence and attack rates at schools A–D, from September 2006 through February 2007.

<table>
<thead>
<tr>
<th>Finding</th>
<th>School A</th>
<th>School B</th>
<th>School C</th>
<th>School D</th>
</tr>
</thead>
<tbody>
<tr>
<td>School population, no. of students</td>
<td>276</td>
<td>483</td>
<td>344</td>
<td>888</td>
</tr>
<tr>
<td>Confirmed* pneumonia</td>
<td>11</td>
<td>27</td>
<td>22</td>
<td>16</td>
</tr>
<tr>
<td><em>M. pneumoniae</em> pneumonia</td>
<td>7</td>
<td>20</td>
<td>18</td>
<td>12</td>
</tr>
<tr>
<td>Pneumonia attack rate, %</td>
<td>4.0</td>
<td>5.6</td>
<td>6.4</td>
<td>1.8</td>
</tr>
<tr>
<td>Pneumonia incidence rate,a, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annualized</td>
<td>90</td>
<td>126</td>
<td>144</td>
<td>41</td>
</tr>
<tr>
<td>Expected annualized,c</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>12</td>
</tr>
<tr>
<td>Case patient* age, median, years</td>
<td>8.4</td>
<td>6.9</td>
<td>8.5</td>
<td>12</td>
</tr>
</tbody>
</table>

NOTE. Data are the no. of cases, unless otherwise indicated.

* Clinically or radiographically.

* Per 1000 student-years.

* Expected rate generated using data from the Group Health Cooperative.

* Case patients with pneumonia.

Figure 1. Number of cases of pneumonia among students at schools A–D in Rhode Island, by week of symptom onset, from September 1 2006 through 9 February 2007.
Three students developed neurologic disease during the fourth month of the outbreak period (in early December), after experiencing respiratory prodromes. Two students were considered to have *M. pneumoniae*–associated neurologic disease, because they had positive results of *M. pneumoniae* IgM serologic testing and had no alternative diagnosis. These 2 students were a 7-year-old student who had encephalitis at school A and a 14-year-old student at school D who had ADEM. The third student, a 7-year-old classmate of the case patient at school A died of encephalitis but was seronegative for *M. pneumoniae*. No other etiology was identified, despite exhaustive testing. Severe *M. pneumoniae*–associated dermatologic disease was identified in a 7-year-old student from school A who developed Stevens-Johnson syndrome after receiving treatment with azithromycin.

Questionnaires were completed for 267 students (97%) at school A who were residing in 201 households. OP swab specimens were collected from 144 students (54%); 55 students (21%) provided a single serum sample. Questionnaires were completed for 623 (97%) of the household contacts of participating students; 303 of these 623 household contacts (49%) provided OP swabs, and 80 (13%) provided serum samples.

Of the individuals who completed questionnaires, 10 students at school A and 3 household contacts had pneumonia; 35 students and 52 household contacts reported visits for cough. Respondents who had pneumonia were more commonly seropositive than were those who had not sought care, a finding that suggests that *M. pneumoniae* was the etiology of their illness (table 2). Five PCR-positive specimens obtained from persons without pneumonia were selected for culture; *M. pneumoniae* was isolated from 4 of these specimens.

Rates of visits for pneumonia and cough were higher among children than adults (figure 2). Most visits for pneumonia and cough occurred in late November and December (figure 3).

For 266 students at school A, the rate of visits for pneumonia or cough was 17%; for 99 siblings of students at school A who were <12 years of age and who were not attending school A the rate was 25% (P = not significant). After adjustments were made for age and stratification by household, being a student at school A was not significantly associated with developing pneumonia or making a visit for cough (adjusted OR, 1.3 [95% CI, 0.32–5.1]). Classroom-specific attack rates varied widely, with all but 2 of the 15 classrooms having ≥1 student with a visit for pneumonia or cough.

Instances of visits for pneumonia or cough were concentrated among a small number of households. Twenty households (10%) reported that ≥2 members made visits for pneumonia or cough; these households accounted for 61% of all visits for pneumonia or cough. We tested the null hypothesis (i.e., no clustering among household members) through simulation. We randomly assigned a 0.112 probability of being a case (equivalent to the overall attack rate of 11.2%) to each member of the population independently. After 20,000 simulations, we found no instances in which households with ≥2 affected individuals constituted 60% of the cases. In other words, the probability that chance alone accounted for the clustering observed was essentially zero. Index case patients were identifiable in 10 of these 20 households: 6 were students and 4 were other household members. Most households (142 [71%]) had no members who made visits for pneumonia or cough.

Table 2. *Mycoplasma pneumoniae* assay results for school A students and household contacts with pneumonia, those with visits for cough, and those with no health care visit for cough.

<table>
<thead>
<tr>
<th>Assay</th>
<th>Those with pneumonia</th>
<th>Those with a visit for cough</th>
<th>Those with no health care visit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total tested</td>
<td>With a positive test result</td>
<td>P</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IgG/IgM</td>
<td>8</td>
<td>8 (100)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>IgM</td>
<td>8</td>
<td>8 (100)</td>
<td>.017</td>
</tr>
<tr>
<td>Mycoplasma PCR</td>
<td>7</td>
<td>1 (14)</td>
<td>.0015</td>
</tr>
</tbody>
</table>

NOTE. Data are no. or no. (%) of persons, unless otherwise indicated. PCR, polymerase chain reaction.

*a* “Visit for cough” was defined as a first visit made to a health care provider for cough illness during the outbreak period by a person not subsequently diagnosed with pneumonia.

*b* No visit indicates individual did not seek care for cough.

*c* Compared with no visit, by use of the χ² test.

*d* Remel.

*e* Meridian.
household contacts lived in these households; of these contacts, 8 (42%) developed pneumonia, and an additional 6 (32%) made a visit for cough. Four of the 6 households were located within a 1-block radius of each other. Interviews demonstrated intense social out-of-school contact among children from at least 5 of the 6 households.

Figure 2. Attack rates of pneumonia and rates of physician visits for cough for students at school A in Rhode Island and their household contacts, by age, from September through December 2006.

Figure 3. Number of students at school A in Rhode Island and their household contacts who had visited a physician for cough or who had pneumonia, Mycoplasma-associated neurologic disease, or severe Mycoplasma dermatologic disease diagnosed, by week of visit or diagnosis, from September through December 2006.
DISCUSSION

A large community outbreak of M. pneumoniae infection went undetected for months, until a cluster of cases of life-threatening neurologic illness was identified. The findings of the present study, which provide, for the first time in decades, a description of M. pneumoniae transmission during a community outbreak, suggest that some apparently sporadic M. pneumoniae infections may be associated with unrecognized community outbreaks. Typical of the manifestation of M. pneumoniae disease, most infected persons presented with tracheobronchitis, a minority developed pneumonia, and a smaller fraction developed severe extrapulmonary syndromes [3, 32]. In the 1970s, investigators described community outbreaks of M. pneumoniae infection as “indolent epidemics” [33]. The outbreak described in the present study displayed this characteristic prolonged course.

Although this outbreak of M. pneumoniae was initially identified in schools, households were found to be an important site of disease transmission. Forty-two percent of household contacts of a student with pneumonia also developed pneumonia, a rate of attack similar to the rates reported in 3 family studies of M. pneumoniae pneumonia from nearly 40 years ago [27, 28, 34]. Although transmission likely occurred in schools as well as within households, students were no more likely than their non-student siblings to have had pneumonia or to have visited a physician because of cough. Indeed, detection of disease among students in 4 geographically close schools indicated that transmission of M. pneumoniae occurred widely in the community.

Early detection of community outbreaks of M. pneumoniae infection is important because control measures might have the potential to limit transmission and prevent severe extrapulmonary sequelae [17]. Because M. pneumoniae-specific surveillance is not routinely conducted, detection of community outbreaks of M. pneumoniae infection will likely continue to depend on astute clinicians having a high index of suspicion for M. pneumoniae infections and on reporting of occurrences to local and state public health departments [19, 26, 35]. Schools—in particular, school nurses—can play an important role in detection by identifying and reporting clusters of cases of pneumonia.

Our investigation also illustrates the challenge of using laboratory results to confirm a community outbreak of M. pneumoniae infection. The rapidity and sensitivity of PCR make it useful for acutely ill persons who do not yet have detectable IgM antibodies [3], although the actual sensitivity may depend on the

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**Figure 4.** Cases of pneumonia and instances of visits for cough among school A households that had a student receive a diagnosis of pneumonia, from October through December 2006. y/o, year old.
specimen type used [36]. PCR will not confirm the etiology of cases of pneumonia that occurred months earlier, as is likely during outbreaks of Mycoplasma infection. An increase in \textit{M. pneumoniae} antibody levels between paired acute-phase and convalescent-phase serum samples provides specific evidence of infection but may not be feasible during the initial response to a suspected outbreak. Although less specific, a high rate of IgM seropositivity among children after testing of single specimens may provide a rapid indication that \textit{M. pneumoniae} is the cause of a community outbreak.

Because systematic evaluations of the effectiveness of interventions during outbreaks are rarely feasible, the optimal public health response to community outbreaks of \textit{M. pneumoniae} infection is unclear. In the few recent reports of such outbreaks, a variety of control measures have been attempted, including alerting health care providers of the outbreak and testing and treating asymptomatic close contacts [19, 23, 26]. Our experience suggests that school-based interventions alone are unlikely to be sufficient in halting the transmission of \textit{M. pneumoniae}, because transmission is typically highest in households [27, 28] and may occur throughout the community. In addition, students may congregate outside of school, thereby reducing the effectiveness of school closures [37]. Therefore, in addition to using school-based measures, public health officials should also direct interventions toward interrupting transmission in households, particularly households with young children. Communication with parents should emphasize cough etiquette, the importance of seeking care for children with febrile cough illness, and the use of hand washing or alcohol-based gels, a strategy that has been shown to limit household transmission of lower respiratory tract illnesses [38]. Community health care providers can test for and identify patients with \textit{M. pneumoniae} illness, counsel families regarding measures to limit household transmission, and use antibiotics with activity against \textit{M. pneumoniae} when treating pneumonia.

Specific indications for antimicrobial prophylaxis or therapy for household contacts have not been established [39–41]. Oxytetracycline prevented symptomatic illness among household contacts of persons with \textit{M. pneumoniae} infection in single small study in 1967 [41], and the results of several studies have indicated that prophylaxis with macrolides or doxycycline may attenuate outbreaks in closed congregate settings [6, 7, 42]. Nonetheless, because the majority of exposed household contacts will remain asymptomatic or develop mild self-limited illnesses, prophylactic antibiotics are not routinely recommended. Antibiotic prophylaxis may be appropriate for individuals at particularly high risk of developing severe illness due to \textit{M. pneumoniae}, such as children with sickle-cell disease, Down syndrome, or immunosuppression [43].

Persons with cough and fever who are household contacts of persons with confirmed \textit{M. pneumoniae} pneumonia also are likely to be infected with \textit{M. pneumoniae}. Such persons should be evaluated and treated with appropriate antibiotics if pneumonia is present. Although antibiotics are not routinely indicated for acute bronchitis caused by \textit{M. pneumoniae} [44, 45], the increased risk for pneumonia among household contacts of \textit{M. pneumoniae}–infected case patients may justify administration of antibiotics to persons with bronchitis who are household contacts of patients with pneumonia caused by \textit{M. pneumoniae}.

Our investigation had several limitations. First, clinical case definitions lack sensitivity and specificity. Persons infected with \textit{M. pneumoniae} may experience clinical illness without visiting a physician. Also, despite the extensive testing performed and the fact that occurrence of visits for cough mirrored the occurrence of pneumonia, it is likely that some visits for cough occurred as a result of infection with pathogens other than \textit{M. pneumoniae}. Second, the value of using a single serologic specimen for \textit{M. pneumoniae} serologic testing has been debated [46–48]. Limited sensitivity, specificity, and reproducibility diminish the clinical usefulness of such specimens. In an epidemiologic investigation, however, high rates of seropositivity among persons with pneumonia implicate \textit{M. pneumoniae} as the etiology [49]. Third, we compared rates of physician–documented pneumonia identified through active case finding in outbreak-affected schools in RI with rates of pneumonia-specific ICD-9-CM codes recorded in outpatient and inpatient settings in a large health maintenance organization in Washington. Because definitions and methods of data collection differed, rate differences cannot be considered to be precise estimates. Nonetheless, we believe that this indirect comparison is sufficiently valid to support the presence of an outbreak. Fourth, household clustering of disease might occur through mechanisms other than \textit{M. pneumoniae} transmission—for instance, if household members share patterns of care seeking. Nonetheless, high secondary attack rates of pneumonia suggest that disease transmission is an important contributor to clustering. Finally, it was not feasible to incorporate systematic evaluation of control measures in this emergency response.

Community outbreaks of \textit{M. pneumoniae} can cause a large burden of illness, including extrapulmonary sequelae that are less common but severe. Early detection of such outbreaks could enable measures to prevent severe morbidity, but effective methods of detection are lacking. Providers and public health practitioners should have a high index of suspicion for \textit{M. pneumoniae} when a cluster of pneumonia is identified among children or young adolescents. The site at which an outbreak is recognized may not be the primary site at which transmission is occurring. Interruption of household-based transmission should be one of the main objectives of control efforts.

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References


