Illness Among Schoolchildren During Influenza Season

Effect on School Absenteeism, Parental Absenteeism From Work, and Secondary Illness in Families

Kathleen M. Neuzil, MD, MPH; Cynthia Hohlbein, RN; Yuwei Zhu, MD, MS

Background: High attack rates of Influenzavirus among school-aged children tend to be expected to cause significant disruption of usual activities at school and at home.

Objective: To quantify the effect of influenza season on illness episodes, school absenteeism, medication use, parental absenteeism from work, and the occurrence of secondary illness in families among a cohort of children enrolled in an elementary school during the 2000-2001 influenza season.

Design: Prospective survey study.

Setting: Kindergarten through eighth grade elementary school in Seattle, Wash.

Patients or Other Participants: All children enrolled in the school were eligible for the study. Study participants were 313 children in 216 families.

Main Outcome Measures: The primary outcome measure was missed school days. Secondary outcomes measures included total illness episodes, febrile illness episodes, medication usage, physician visits, parental workdays missed, and secondary illnesses among family members of children in the study cohort. Differences between the rates of study events among participants when influenza was circulating and the event rates during the winter season when influenza was not circulating were used to calculate influenza-attributable excess events.

Results: Total illness episodes, febrile illness episodes, analgesic use, school absenteeism, parental industrial absenteeism, and secondary illness among family members were significantly higher during influenza season compared with the noninfluenza winter season. For every 100 children followed up for this influenza season, which included 37 school days, an excess 28 illness episodes and 63 missed school days occurred. Similarly, for every 100 children followed up, influenza accounted for an estimated 20 days of work missed by the parents and 22 secondary illness episodes among family members.

Conclusion: Influenza season has significant adverse effects on the quality of life of school-aged children and their families.

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Influenza causes annual winter epidemics of respiratory disease that affect all age groups and all segments of the population. Serious complications and hospitalizations due to Influenzavirus occur preponderantly in persons younger than 2 years, persons 65 years and older, and persons with certain chronic medical conditions. Deaths occur preponderantly in persons older than 70 years. However, even among otherwise healthy individuals, the health and economic consequences of influenza are substantial. Annual influenza attack rates vary from 10% to 30% in adults and 20% to 50% in children during interpandemic years, and may approach 70% during pandemic years. Among adults, influenza infections lead to increased health care visits, medication usage, work loss, and restricted activity days.

While the epidemic nature of influenza and the high attack rates in children would be expected to cause significant disruption of usual activities at school and at home, data on the effects of influenza on school-aged children are limited. In a study of healthy children aged 5 through 14 years enrolled in Tennessee Medicaid, influenza was associated with a health care visit in approximately 8% of the children and with an antibiotic prescription in approximately 7%. This study likely underestimated the effect of influenza on this population, as it did not examine the effects of influenza on school-aged children who did not seek medical care. Additional adverse effects of influenza in this population include the dis-
comfort of the illness, increased over-the-counter medication usage, and school absenteeism. Influenza in a child may also affect the family. Working parents may stay home to care for a sick child, leading to industrial absenteeism, or sick children may transmit Influenzavirus to other family members. Considering the potential for influenza to substantially affect the quality of life of children and their families, targeting school-aged children for prevention or treatment of influenza may reduce the individual and societal burden of this disease. This prospective study was designed to quantify the effect of influenza season on school and industrial absenteeism, on health care and medication usage, and on secondary illnesses within families, among a cohort of schoolchildren and their families.

PARTICIPANTS AND METHODS

STUDY DESIGN

We conducted a 1-year prospective study of the effect of influenza season on a cohort of children enrolled in a large elementary school in Seattle, Wash. Baseline surveys obtained information on household size, prevalence of childhood asthma, and receipt of influenza vaccine. When a child was absent from school during the winter season, from December 4, 2000, through April 13, 2001, surveys were sent to the child’s parent or guardian to determine the reason for the absence, to characterize the types and severity of illnesses that occurred during the winter season, and to determine the effect of the illness on medication usage, physician visits, parental industrial absenteeism, and secondary illnesses within the family.

This study was approved by the Human Subjects Division at the University of Washington. Baseline surveys and informed consent were sent to all parents at the school. Parents chose to enroll in the study by returning the baseline survey and the accompanying informed consent. After receiving the informed consent from the parents, two of us (K.M.N., C.H.) obtained assent from the children. These children and their families constituted the study population.

SOURCE POPULATION

The study school is a parochial elementary school (grades kindergarten–8) located in central Seattle and draws children from 24 ZIP codes within the city, and 14 ZIP codes from the surrounding suburbs. The school represents an ethnically and socioeconomically diverse population of children. Of a total enrollment of 611 children, 18% are nonwhite; almost 20% receive financial aid.

DATA COLLECTION

Baseline Data

Baseline data on household size, ages of all household members, and receipt of influenza vaccine by each member of the family was collected from all of the 216 families who chose to participate. To determine the prevalence of asthma among the schoolchildren, the survey also included a question asking whether a physician had ever diagnosed asthma for the child.

Illness Data

Coded, computerized absentee records were obtained by the study coordinator (C.H.) from the school office at the end of each week. Children who were participating in the study were identified. From December 4, 2000, through April 13, 2001 (the day before spring break), the parent or guardian of a child listed on the computerized absentee records was sent a survey inquiring about the child’s reason for missing school. If the child missed school for an illness, then the parent completed the remainder of the form, which asked details about the symptoms of the illness, medication usage, health care use, parental industrial absenteeism, and illnesses among other household members. The following symptoms were included on the survey: fever, coryza, sore throat, cough, myalgia, earache, headache, nausea, vomiting, and diarrhea. Parents returned the surveys in stamped, self-addressed envelopes to the study nurse (C.H.). If the survey was not received by the study nurse within 2 weeks, a telephone call was placed, and the details of the absence were ascertained by telephone interview.

Influenza Season

Influenza season was defined by prospective viral surveillance at the University of Washington Clinical Virology Laboratory at Children’s Hospital and Medical Center. Influenza season was defined as the first day of the first week in which there were at least 5 isolates of Influenzavirus, until the last day of the last week in which there were at least 5 isolates of Influenzavirus.

MAIN OUTCOME MEASURES

The primary outcome measure was the total number of school days missed during influenza season compared with the noninfluenza winter season. Secondary outcomes included the total illness episodes, febrile illness episodes, other symptoms associated with the illness episodes, number of days that parents miss work secondary to childhood illness, the number of family members who become ill within 3 days of the child’s illness, and the number of health care visits and medications dispensed during influenza season.

DATA ANALYSIS

The expected number of study outcomes during influenza season was calculated based on the rate of study outcomes observed during the noninfluenza winter season. The observed number of study events during influenza season was then compared with the expected number, and a relative risk was calculated. Influenza-attributable excess events were calculated by subtracting the expected outcomes from the observed outcomes during influenza season. An excess event rate per 100 children was then generated by dividing by the total number of children in the cohort (313), then multiplying by 100. The 95% confidence intervals were generated using StatXact (Cytel Software, Cambridge, Mass). χ² or Fisher exact test was used as appropriate for symptom comparison between the influenza and noninfluenza winter season. In an attempt to control for the confounding effect of respiratory syncytial virus (RSV) circulation, a nested analysis was performed that was restricted to January 8, 2001, through March 31, 2001, during which the mean number of RSV isolates per week was equivalent during the influenza and noninfluenza winter season. All calculations other than the 95% confidence interval were done using SAS version 8.0 (SAS Institute Inc, Cary, NC).

RESULTS

Of 428 families with 611 children enrolled at the school, 216 families with 313 children chose to participate in the study. Baseline characteristics of the study population are...
RSV isolates per week was higher in influenza season than in the noninfluenza winter season, at 37 and 23 per week, respectively. From January 8, 2001, through March 31, 2001, the mean number of RSV isolates per week was 37 during both influenza season and the noninfluenza winter season. Parainfluenza virus circulated at relatively constant levels throughout the study period (Figure).

**OUTCOME RATES**

Throughout the school year, weekly rates of absenteeism were monitored. The weekly percentage of children in the study who missed school was similar to the percentage of all students who missed school (data not shown). From December 4, 2000, through April 13, 2001, on notification by the school that a study participant missed school, 868 surveys were mailed to parents and 804 (93%) were returned. Of these 804 returned surveys, 360 surveys indicated that either the child did not miss school, or that the child did miss school but was not ill. On 444 surveys, the parents confirmed that the child missed school owing to an illness.

Of the 444 illness episodes, 194 (43.7%) occurred during the noninfluenza winter season, and 250 (56.3%) occurred during influenza season. Among the 313 children monitored throughout the 44 days of the noninfluenza season, 194 illnesses occurred during the 13772 child-days of follow-up. Using this rate as the background rate, the expected number of illness episodes during influenza season was calculated and compared with the observed number. As given in Table 2, the 250 reported illnesses during influenza season exceeded the expected number by more than 50%. The 87 excess illness events occurring among 313 children followed up during winter represents an estimated influenza attack rate of 28%. In addition to total illness episodes, days of school missed per episode was higher during influenza season than during the noninfluenza winter season. Febrile illnesses increased during influenza season, with the difference in illness episodes entirely accounted for by illness episodes with fever. Analgesic use during influenza season, and parental work absenteeism, were likewise higher than expected during influenza season. The observed numbers of antibiotic prescriptions and health care visits were not statistically significantly greater than expected during influenza season (Table 2).

To determine the excess event rate for outcomes during influenza season, the expected rate during influenza season was subtracted from the observed rate (Table 2). It is estimated that for every 100 children followed up for this influenza season, which included 37 school days, an additional 28 illness episodes and 63 missed school days would occur. Similarly, for every 100 children followed up, influenza accounted for an estimated 20 excess days of work missed by the parents. When the study was restricted to periods of peak RSV activity, from January 8, 2001, through March 31, 2001, estimates of influenza-attributable events were similar (data not shown).

During influenza season, parents were much more likely to report illness in other household members in the 3 days following the child’s absence from school compared with the noninfluenza winter season. An estimated 22 excess secondary illness episodes occurred for

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**Table 1. Baseline Characteristics of 313 Children in 216 Families Participating in Illness Survey Study**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Children</strong></td>
<td></td>
</tr>
<tr>
<td>Mean age (range), y</td>
<td>10 (6-15)</td>
</tr>
<tr>
<td>Median grade (range)</td>
<td>4 (kindergarten-8)</td>
</tr>
<tr>
<td>Those who have asthma</td>
<td>12</td>
</tr>
<tr>
<td>Those who ever received influenza vaccine</td>
<td>16</td>
</tr>
<tr>
<td>Those who have received influenza vaccine</td>
<td>6</td>
</tr>
<tr>
<td>this influenza season</td>
<td></td>
</tr>
<tr>
<td><strong>Families</strong></td>
<td></td>
</tr>
<tr>
<td>Children &lt;18 y residing in the household</td>
<td></td>
</tr>
<tr>
<td>With 1 child</td>
<td>22</td>
</tr>
<tr>
<td>With 2 children</td>
<td>49</td>
</tr>
<tr>
<td>With 3 children</td>
<td>23</td>
</tr>
<tr>
<td>With &gt;4 children</td>
<td>6</td>
</tr>
<tr>
<td>Single-parent household</td>
<td>13</td>
</tr>
<tr>
<td>Grandparents residing in the household</td>
<td>3.3</td>
</tr>
</tbody>
</table>

*Data are given as percentages unless otherwise indicated.

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The number of isolates of influenza (solid line), respiratory syncytial virus (large dashed line), and parainfluenza (small dashed line) per week at Children’s Hospital and Regional Medical Center, Seattle, Wash, during the 2000-2001 school year. Adapted from the University of Washington Clinical Virology Laboratory Web site.21

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**Figure**

The number of isolates of influenza (solid line), respiratory syncytial virus (large dashed line), and parainfluenza (small dashed line) per week at Children’s Hospital and Regional Medical Center, Seattle, Wash, during the 2000-2001 school year. Adapted from the University of Washington Clinical Virology Laboratory Web site.21
then generated by dividing the total number of children in the cohort (N = 313), then multiplying by 100.

This Seattle population–based study examined the effect of the influenza season on multiple and diverse outcomes among schoolchildren and their families during the 2000-2001 winter season. Illness during influenza season was common, with an estimated 87 excess illness episodes among children aged 11 to 14 years, but not among younger children. There were no differences in the prevalence of nausea, vomiting, diarrhea, or earache among illnesses in any age group occurring during the influenza and noninfluenza winter season.

### Table 2. Effect of Winter Illness on School and Family Among 313 Schoolchildren Monitored From December 1, 2000, Through April 13, 2001

| Variable                        | Events During the Noninfluenza Winter Season (44 School Days) | Events During Influenza Season (37 School Days) | Influenza-Attributable Events per 100 Children
|--------------------------------|-------------------------------------------------------------|-------------------------------------------------|-------------------------------------------------|
|                                | Expected | Observed | Relative Risk (95% CI) | Expected | Observed | Relative Risk (95% CI) | Expected | Observed | Relative Risk (95% CI)
| No. of illness episodes         | 194      | 163      | 250                 | 1.5      | 1.3-1.9 | 27.8                |          |          |                |
| Total No. of days missed        | 343      | 288      | 485                 | 1.7      | 1.5-1.9 | 62.9                |          |          |                |
| No. of febrile illnesses        | 95       | 80       | 168                 | 2.1      | 1.8-2.7 | 28.1                |          |          |                |
| No. of antibiotic courses       | 23       | 19       | 17                  | 0.9      | 0.5-1.6 | −0.64               |          |          |                |
| No. of analgesics used          | 143      | 120      | 195                 | 1.6      | 1.3-2.0 | 24.0                |          |          |                |
| No. of health care visits       | 54       | 45       | 58                  | 1.3      | 0.9-1.9 | 4.2                 |          |          |                |
| Days of work missed by parent   | 116      | 97       | 159                 | 1.3      | 1.3-2.1 | 19.8                |          |          |                |
| No. of household members ill in 3 days after absence | 69       | 58       | 126                 | 2.2      | 1.6-2.9 | 21.7                |          |          |                |

*Values indicate the comparison of the rate of events during influenza season with the rate of events during the noninfluenza winter season. CI indicates confidence interval.
†Values were calculated by subtracting the expected outcomes from the observed outcomes during influenza season. An excess event rate per 100 children was then generated by dividing the total number of children in the cohort (N = 313), then multiplying by 100.

The effect of influenza season on this cohort extended beyond illness in the schoolchildren. In this study, significant excess industrial absenteeism occurred among the parents, who missed almost 1 day of work for every 3 days of school missed by a child attributable to influenza infection. National data report that 57% of mothers and 97% of fathers of school-aged children work full-time and, thus, may need to miss work or hire alternative care if their children miss school. Presumably, our study population included fewer households with 2 working parents, or parents with more flexibility in their schedules or alternative child care providers. Rates of parental absenteeism could be higher in other populations. Our estimates of parental industrial absenteeism were based solely on missing work to care for a sick child, and did not include work that may have been missed if the child transmitted influenza to the parent.

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Symptomatic influenza illness is frequent among school-aged children. However, studies evaluating the effect of influenza illness on quality of life in such children are unavailable. This prospective, population-based study quantifies a major effect of Influenzavirus on multiple and diverse outcomes in schoolchildren and their families, including significant increases in school absenteeism, analgesic use, parental industrial absenteeism, and secondary illness among family members. Such information is important for both individual and public policy decisions regarding the use of influenza vaccine in school-aged children.

Children more frequently shed Influenzavirus compared with adults, and this may facilitate the transmission of Influenzavirus. In a large general practice population outside London, England, during the pandemic of 1957, attack rates in adults who resided with school-aged children were 2 to 3 times higher than attack rates in adults who did not reside with school-aged children. Family studies of influenza transmission in Seattle and Tecumseh, Mich, during the 1970s found children to be the main introducers of influenza infection into households during interpandemic periods. In this study, the number of household members who became ill within 3 days of a child’s absence from school was 2.2 times higher than expected during influenza season. For every 10 children who miss school for an influenza-related illness, our data suggest that 8 household members will subsequently become ill. Increased use of influenza vaccine among children could reduce illness in household or community contacts. In a 1995 randomized controlled trial of influenza vaccine for preschool-aged children, influenza-unvaccinated household contacts of influenza-vaccinated children had 42% fewer febrile respiratory illnesses compared with unvaccinated household contacts of control children. Mass vaccination of schoolchildren has been correlated with reduced respiratory illness in Tecumseh and with reductions in all-cause mortality rates in Japan, suggesting that immunization on a larger scale can affect community epidemics. This was a survey study, and we did not attempt to diagnose the reported illnesses by clinical or laboratory evaluation. We assumed that noninfluenza illnesses occurred equally during the influenza and noninfluenza winter season, so that any excess during influenza season was attributable to influenza infection. Using a similar method, our estimates of influenza-associated hospitalizations and outpatients visits in children correlated well with laboratory documented rates of influenza disease. That most of the excess illness in this study was febrile illness is consistent with the clinical picture of Influenzavirus in children. Likewise, our secondary analysis that was restricted to peak RSV season yielded results similar to our primary analysis, suggesting that RSV was not a significant confounder.

This study included only 1 influenza season, in which influenza type B and type A (H1N1) strains circulated. The effect of influenza varies from year to year, and may be influenced by circulating strains and the underlying immunity in the population. While in adults morbidity is generally believed to be greatest when H3N2 viruses are circulating, the effect of different viral strains on morbidity in school-aged children is not well established, as all 3 strains may cause high attack rates or serious illness. Studies that include multiple influenza seasons are needed to adequately address this issue.

CONCLUSIONS

Among a cohort of children followed up during the winter season, total illness episodes, school days missed, workdays missed by parents, and subsequent illnesses among household members were significantly increased when Influenzavirus circulated in the community. These data should aid pediatric health care providers and parents when deciding whether to immunize a healthy school-aged child with influenza vaccine. When planning important school events during influenza season, school administrators should be cognizant of the potential for significant increases in school absenteeism. Finally, this study reinforces the recommendation to vaccinate children if they reside in households with persons who are at increased risk for complications of Influenzavirus, to reduce the potential for transmission.

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Corresponding author and reprints: Kathleen M. Neuzil, MD, MPH, University of Washington School of Medicine, Veterans Affairs Puget Sound Health Care System, 1660 S Columbian Way, Seattle, WA 98108 (e-mail: kneuzil@u.washington.edu).

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