Measles Outbreak on a College Campus Transmitted Through Internet Cafés

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Background. During March 2008, a college in Urumqi, capital of Xinjiang Uygur Autonomous Region in China, reported a measles outbreak, amid a city-wide outbreak involving >2,700 cases.

Methods. Suspected case patients were defined as patients with onset of fever (≥38°C) and rash between 7 March and 30 April 2008. Probable case patients were defined as suspected case patients with >3 days of rash or known exposure to someone with laboratory-confirmed measles. Confirmed case patients were defined as suspected or probable case patients with Koplik spots or positive titer for immunoglobulin M antibody. We conducted a case-control investigation to identify risk factors for transmission.

Results. We identified 162 suspected (attack rate, 1.9%), 99 probable, and 62 confirmed case patients. The epidemic curve indicated a point source initially, followed by person-to-person transmission. Approximately 63% of 90 probable case patients and 27% of 150 asymptomatic student controls randomly selected among classmates of student case patients visited internet cafés during the exposure period (odds ratio [OR], 4.5; 95% confidence interval [CI], 2.6–8.0); 66% of case patients and 45% of student controls reported close contact with a measles case patient (OR, 2.3; 95% CI, 1.3–3.9). In stratified analysis, visiting internet cafés (OR, 4.0; 95% CI, 1.5–11) remained significantly associated with disease, but contact with case patients (OR, 1.9; 95% CI, .79–4.4) became nonsignificant.

Conclusions. This measles outbreak was transmitted in internet cafés, followed by secondary transmission. Chinese universities should require proof of immunity or 2 doses of measles vaccine at college entry.

Measles, a highly contagious acute viral illness, can have severe complications such as pneumonia, encephalitis, and death [1]. Despite the availability of an effective vaccine, in 2007 measles was still estimated to have caused 197,000 deaths worldwide, mostly in countries with limited healthcare infrastructure [2]. In China, measles vaccination through the Expanded Program on Immunization started in 1978. The original schedule was 1 dose (0.2 mL) of measles vaccine administered to 8–12-month-old infants [3]; the schedule was amended in 1985 to give children 2 doses of the vaccine at the ages of 8 months and 7 years. In 2006, the National Immunization Program further amended the age of administration of the second dose from 7 years to 18–24 months, and increased the volume of vaccine in both doses from 0.2 to 0.5 mL, whereas the same type of antigen has been used in the vaccine since the 1980s [4]. Despite the implementation of measles vaccination, measles outbreaks continue to occur throughout China [5–9]. In China’s western Xinjiang Uygur Autonomous Region, the measles vaccination program was not officially implemented until 1984. Since 1986, Xinjiang has been in compliance with the National Immunization Program’s requirements regarding the age of administration and dosage [10]. In 2004, Xinjiang conducted a province-wide supplemental immunization activity
targeting all children aged 8 months to 13 years, with reported
coverage of up to 95% [11].

From November 2007 to June 2008, a large measles outbreak,
with >2700 reported cases, occurred in Urumqi, the capital city
of Xinjiang. On 30 March 2008, a local hospital reported that
~50 students in a college were infected with measles. We in-
vestigated this outbreak to identify risk factors for transmission
and to recommend control measures for preventing future
outbreaks.

METHODS

Among students, teachers, and staff of the college, suspected
measles case patients were defined as those with fever ($\geq 38^\circ$)
and rash, with onset of fever between 7 March and 30 April 2008.
Probable case patients were defined as suspected case patients
with $>3$ days of rash or known exposure to a laboratory-
confirmed case patient. Fever was determined on measurements
in a hospital or at school. Confirmed case patients were sus-
ppected or probable case patients with Koplik spots (ascertained
by experienced physicians) or positive titers for measles-specific
immunoglobulin (Ig) M antibody [12] (tested for all probable
case patients).

We conducted case finding among all teachers, students, and
staff of the college. The head teachers of all classes in the college
were trained to measure the body temperature and look for skin
rash for each student daily. If a student had fever or skin rash,
the student would be isolated for further observation and test-
ing. Once students met the definition of a probable case patient,
they were sent to the hospital immediately for isolation, con-
firmative diagnosis, and treatment. The detection of specific
serum IgM antibodies was conducted using a commercially
available IgM capture enzyme-linked immunosorbent assay
[13]. The reagent was obtained from Virion/Serion in Wurzburg,
Germany (batch no. 0903).

We conducted a case-control investigation to evaluate po-
tential risk factors for measles infection and transmission, using
an investigator-supervised self-administered questionnaire or
face-to-face interviews. Because very few teachers contracted
measles during this outbreak, we included only students in the
case-control investigation. We recruited all students who were
probable case patients to participate in the case-control in-
vestigation and collected information about their exposure
histories during the 2 weeks before their disease onset. We
randomly selected controls among asymptomatic students who
reportedly did not have a history of measles infection, frequency
matched for grade and sex at a ratio of approximately 1 case
patient to 2 controls. The exposure histories during the 2 weeks
before measles onset in the case patients were evaluated in the
controls with the same questionnaire used to interview case
patients. Vaccination histories of both case patients and controls
were based on the respondents’ recall, because immunization
records were unavailable for the student case-patients. This in-
vestigation was in response to a public health emergency; hence,
human subject review was not required.

RESULTS

Description of Outbreak
The outbreak began on 7 March (the third week after school
resumption) and lasted until 30 April, a total of 56 days. We
identified 162 suspected case patients (attack rate, 1.9%), of
whom 99 were probable and 62 were confirmed case patients;
159 were students, and 3 were teachers or staff. All 162 suspected
case patients (100%) had fever, 160 (99%) had rash, 82 (51%)
had Koplik spots, 81 (50%) had coughing, 60 (37%) had con-
junctivitis, 40 (25%) had coryza, and 27 (17%) reportedly had
a history of measles vaccination. The case patients had no un-
usual complications.

The epidemic curve indicated a point source in the beginning
of the outbreak resulting from a brief period of exposure, fol-
lowed by person-to-person transmission. After the outbreak
was detected, the county center for disease control and preven-
tion conducted 3 college-wide emergency vaccination campaigns,
the first on 31 March (Figure 1).

Hypothesis Generation
The attack rate did not differ significantly between students
(1.9%) and teachers or staff (2.3%). On the other hand, male
students were nearly twice as likely as female students to be
infected; boarding students living off campus were $>7$ times,
and boarding students living on campus were $>3$ times as
likely as commuting students to be infected. (In Chinese
colleges, most students live in dormitories on campus; a small
proportion of students live in off-campus dormitories for

\begin{figure}
\centering
\includegraphics[width=\textwidth]{fig1.png}
\caption{Onset of measles cases during a 2008 outbreak on a college
campus in Urumqi, Xinjiang Uygur Autonomous Region, China.
Numbers on vertical axis represent number of cases; numbers on horizontal axis,
dates in February through April; local CDC: county center for disease
control and prevention.}
\end{figure}
freedom and convenience.) Moreover, students living in the 2 dormitories near the main entrance of the campus were more than twice as likely to contract measles as those living in the 2 dormitories far from the main entrance (Table 1). No significant clustering of cases by dormitory or class was detected.

When we conducted hypothesis-generation interviews of selected student case patients, many of the student case patients reported spending time in the internet cafés outside the campus. There were 5 internet cafés outside the main entrance of the campus, and 1 outside the rear entrance. The locations of the internet cafés, along with the descriptive epidemiologic findings that male students and dormitory students (especially those living off campus, who enjoyed more freedom to visiting internet cafés) had higher attack rates, indicated that the initial stage of the outbreak may have been caused by transmission in the internet cafés, although off-campus students may also have had more opportunities to be exposed to a community transmission of measles. When we interviewed the primary case, he also admitted that he had visited internet cafés while symptomatic. This hypothesis is also consistent with the sex difference in the attack rate, for among Chinese college students, male students are typically more likely than female students to visit internet cafés.

**Case-Control Investigation**

Approximately 63% of the 90 students who were probable (including 59 confirmed) case patients visited internet cafés during the exposure period, compared with 27% of the 150 student controls (odds ratio [OR], 4.5; 95% confidence interval [CI], 2.6–8.0). When we investigated associations with basement versus ground-level cafés, compared with 23% of the student case patients and 73% of the student controls who never visited internet cafés, 74% of the student case patients and 48% of the student controls usually visited basement cafés (OR, 11; 95% CI, 5.2–25), and 26% of the student case patients and 53% of the student controls usually visited ground-level cafés (OR, 3.7; 95% CI, 1.5–9.0) (Table 2). Moreover, 66% of the student case patients and 45% of the student controls reportedly had close contact with a known measles case patient (OR, 2.3; 95% CI, 1.3–3.9).

Additionally, 27% of the student case patients and 41% of the student controls reportedly had a history of receiving measles vaccine as a child (OR, .52; 95% CI, .29–.91) (Table 3). These college students were born between 1985 and 1989, when Xinjiang had just started to promote measles vaccination and the volume of the vaccine was .2 mL (as opposed to the current .5 mL) [4]. No other group activities during the possible exposure time window were associated with disease risk.

In the stratified analysis, where variables were examined in isolation, visiting an internet café remained significantly associated with disease (OR, 4.0; 95% CI, 1.5–11), whereas contact with a known case patient became statistically nonsignificant (OR, 1.9; 95% CI, .79–4.4) (Table 3). When we used logistic to control for all 3 risk factors simultaneously, visiting an internet café remained significantly associated with disease (adjusted OR, 8.0; 95% CI, 4.3–15), whereas the association of measles with contact with a known case patient (adjusted OR, 1.8; 95% CI, .98–3.3) and immunization history (adjusted OR, .56; 95% CI, .29–1.1) became borderline significant.

**Table 1. Measles Attack Rate, by Sex, Occupation, Type of Accommodation During a 2008 Outbreak on a College Campus in Xinjiang Uygur Autonomous Region, China**

<table>
<thead>
<tr>
<th>Patient characteristics</th>
<th>Total population, no.</th>
<th>Case patients, no.</th>
<th>Attack rate, %</th>
<th>Rate ratio (95% CI)\textsuperscript{a}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>8442</td>
<td>162</td>
<td>1.9</td>
<td>...</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>3300</td>
<td>90</td>
<td>2.7</td>
<td>1.9 (1.4–2.7)</td>
</tr>
<tr>
<td>Female</td>
<td>5142</td>
<td>72</td>
<td>1.4</td>
<td>Reference</td>
</tr>
<tr>
<td>Occupation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student</td>
<td>8309</td>
<td>159</td>
<td>1.9</td>
<td>.85 (0.27–2.6)</td>
</tr>
<tr>
<td>Teacher or staff</td>
<td>133</td>
<td>3</td>
<td>2.3</td>
<td></td>
</tr>
<tr>
<td>Housing accommodation for students</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boarding student living off campus</td>
<td>680</td>
<td>30</td>
<td>4.4</td>
<td>7.1 (3.5–14)</td>
</tr>
<tr>
<td>Boarding student living in college dormitory</td>
<td>6021</td>
<td>122</td>
<td>2.0</td>
<td>3.3 (1.7–6.2)</td>
</tr>
<tr>
<td>Commuting student</td>
<td>1608</td>
<td>10</td>
<td>.62</td>
<td>Reference</td>
</tr>
<tr>
<td>Location of dormitories</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Near main entrance</td>
<td>843</td>
<td>32</td>
<td>3.8</td>
<td>2.2 (1.5–3.4)</td>
</tr>
<tr>
<td>Far from main entrance</td>
<td>5178</td>
<td>90</td>
<td>1.7</td>
<td>Reference</td>
</tr>
</tbody>
</table>

**NOTE.** CI, confidence interval.
DISCUSSION
Measles can be transmitted by airborne or droplet exposure. The virus has been shown to survive in fine droplets for 2 h [13, 14]. Our study documents a large measles outbreak on a college campus, involving 162 cases. This outbreak was most likely initiated by transmission in internet cafes around the campus, followed by secondary transmission. The primary case patient, who admitted to having visited internet cafes while symptomatic, might have been the source of this outbreak; alternatively, the university outbreak occurred in the midst of a large, city-wide outbreak, so other infectious patients may have been present in the internet cafes during the possible exposure period. Not surprisingly for an airborne disease, frequenting basement internet cafes, which have comparatively poorer ventilation, was a stronger risk factor for acquisition of measles than ground-floor internet cafes.

The student patients during this outbreak, whose ages ranged from 19 to 23 years at the time of this investigation, were born between 1985 and 1989, when measles vaccination was just being introduced to Xinjiang. Reported coverage based on administrative data during 1986–1989 was 68% [15]; moreover, the children who were vaccinated during that period received only 1 dose of vaccine. They were also too old to be targeted during the supplemental immunization program in 2004 and may thus represent an age group with persistent susceptibility to measles.

To date, Chinese universities have no standard policy of requiring proof of measles vaccination or immunity to measles at entry to the university. Such requirements are now in place in several other parts of the world (eg, the United States [16]) after large college-based outbreaks. Since 2006, China has declared a measles elimination goal and has embarked on aggressive vaccination activities to ensure immunity in all children. With decreasing susceptibility in younger age groups, an increasing percentage of nationwide measles cases occur in older adolescents and young adults. A first step to decreasing transmission in these age groups would be to ensure immunity in known high-risk groups, including college students.

This outbreak also shows the success that can be achieved with outbreak response immunization in closed settings such as college campuses. The county center for disease control and prevention conducted its first emergency vaccination on 27 March; transmission essentially ceased 2 weeks later, with the exception of 3 single cases.

Table 2. Visiting Internet Cafés as Risk Factor for Acquisition of Measles

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>No. of students</th>
<th>Exposure rate, %</th>
<th>Mantel-Hanszel odds ratio (95% CI)a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of internet cafés</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>Case patients 57</td>
<td>Controls 41</td>
<td>Case patients 63</td>
</tr>
<tr>
<td>Normally used basement cafés</td>
<td>42</td>
<td>19</td>
<td>74</td>
</tr>
<tr>
<td>Normally used ground-level cafés</td>
<td>15</td>
<td>21</td>
<td>26</td>
</tr>
<tr>
<td>No</td>
<td>33</td>
<td>109</td>
<td>37</td>
</tr>
<tr>
<td>Contact with known case patient</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>59</td>
<td>69</td>
<td>66</td>
</tr>
<tr>
<td>No</td>
<td>31</td>
<td>82</td>
<td>34</td>
</tr>
<tr>
<td>History of measles vaccination</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>24</td>
<td>62</td>
<td>27</td>
</tr>
<tr>
<td>No</td>
<td>66</td>
<td>88</td>
<td>73</td>
</tr>
</tbody>
</table>

NOTE. CI, confidence interval.

Table 3. Stratified Analysis of Visits to Internet Cafés and Contact with Known Case Patients as Risk Factors for Exposure to Measles

<table>
<thead>
<tr>
<th>Exposure factor</th>
<th>Students, no.</th>
<th>% having exposure factor</th>
<th>Odds ratio (95% CI)a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visits to internet cafés</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contact with known case patient</td>
<td>Case patients 40</td>
<td>Controls 22</td>
<td>65</td>
</tr>
<tr>
<td>No contact with known case patient</td>
<td>17</td>
<td>19</td>
<td>47</td>
</tr>
<tr>
<td>No visits to internet cafés</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contact with known case patient</td>
<td>19</td>
<td>46</td>
<td>29</td>
</tr>
<tr>
<td>No contact with known case patient</td>
<td>14</td>
<td>63</td>
<td>18</td>
</tr>
</tbody>
</table>

NOTE. CI, confidence interval.
Our study had several limitations. Because of the ages of the case patients and controls, most did not know their vaccination history; therefore we were unable to examine the role of vaccination in the outbreak. In addition, although we found that using internet cafés was a risk factor for measles disease, we did not examine the role of community transmission. “Close contact” was not well defined in this study, and presence in an internet café does not exclude close contact concurrently with multiple case patients. Internet cafés are a likely source of spread, but our findings do not allow differentiation between direct contact and airborne transmission in these cafés. Finally, 34% (31 of 90) of the case patients in our case-control study did not have laboratory-confirmed measles.

Our study documented the first measles outbreak we are aware of that implicated internet cafés in the transmission of measles. Although measles is best avoided through vaccination, this outbreak investigation demonstrates clearly the increased risk of airborne disease transmission in settings with poor ventilation.

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**References**