Bats in the Belfry: An Outbreak of Histoplasmosis

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Abstract: The belfry and attic of a 100-year-old school building located in central Illinois were infested with a colony of big brown bats (Eptesicus fuscus). During the week of April 14, 1980, four workers disturbed the piles of bat droppings in the attic, causing dust to become airborne. Seven to 10 days later, all four workers developed symptoms and chest x-ray findings compatible with acute pulmonary histoplasmosis. Their sera had complement fixation (CF) titers of ≥ 1:32 with fungal antigens and showed M and/or H bands by immunodiffusion tests. An additional 73 persons who had visited the building were also studied, leading to the finding of 16 additional cases of acute pulmonary histoplasmosis, identified on the basis of positive serologies and compatible symptoms. H. capsulatum was isolated from the sputum of one patient and from the soil beneath the hole in the building’s eaves where the bats had been entering the attic. Cases were associated with exposure to the attic and with total hours of building exposure when compared with controls. The epidemic curve suggests that sporadic exposures occurred during the spring of 1980, with an epidemic occurring after the bat droppings were disturbed by the four workers. (Am J Public Health 1982; 72:1369–1372.)

Introduction

Numerous outbreaks of histoplasmosis have followed exposure to bat dropping deposits in caves, and Histoplasma capsulatum has frequently been isolated from bat droppings found in caves. The first reported outbreak was associated with cave exploration in 1948. A 1955 epidemic of histoplasmosis among cave explorers in Venezuela was confirmed by complement fixation (CF) serology, histoplasmin skin tests, and isolation of H. capsulatum from the soil. Additional histoplasmosis outbreaks associated with bat infested caves were reported from South Africa, Peru, Florida, and Panama. Outbreaks also occurred in 1951 and 1979 among workers who were scraping bat droppings from bridges in Maryland. The following report concerns an epidemic of histoplasmosis associated with a bat-infested school building in Illinois.

Background

The Old East School, located in Pittsfield, Illinois, is a three-story brick building constructed in the late 1800s and renovated in 1978 by the local historical society after several years of disuse. The building housed a community college, a theater guild, a historical society, and a nursing colony of 200 to 250 big brown bats (Eptesicus fuscus) which had gained access to the attic through a hole under the eaves. Bat droppings were scattered over the attic floor but were concentrated in seven piles totaling two to three bushels of droppings. The floor of the attic had numerous holes and cracks through which dust and droppings could fall to lower floors. Several abandoned ventilation ducts connected the attic to the first and second floors.

During the fall of 1979, a heating and ventilation worker became ill one to two weeks after working in the Old East School attic. He was hospitalized in January 1980 and found to have chronic pulmonary histoplasmosis.

From April 14–18, 1980, four employees of the Old East School worked in the attic moving lumber and equipment and attempting to rid the attic of bats. They created dust which, according to two observers, drifted down the attic staircase to the second floor. All four workers became ill, and two of them were admitted to separate hospitals because of fever, chills, and acute respiratory symptoms. Reports of an acute respiratory illness among these and other persons visiting the building prompted a search for additional cases.

Methods

Persons affiliated with the community college, theater guild, or historical society who had visited the Old East School between April 14 and May 16, 1980, were asked to attend a clinic at the Pike County Health Department on May 30, 1980. Students and faculty of the community college were advised by telephone to attend the clinic. Representatives of the theater guild and the historical society notified their members, and an announcement appeared in the local news.
A questionnaire requesting information regarding age, sex, details of exposure to the building, dates of illness onset, and specific symptoms were administered to the 77 persons attending the clinic.

A case was defined as a person who had been in the school building or on the grounds immediately adjacent to the building between April 14 and May 16 and had two or more of the following symptoms: fever, malaise, cough, chest pain, weight loss, and serologic evidence of infection.* Those persons who met either our symptomologic or serologic criteria, but not both, were considered suspect cases. The remaining asymptomatic seronegative individuals who were exposed to the building or adjacent grounds during the designated period of time were considered to be exposed controls.

Serum specimens were obtained from the 77 persons attending the clinic on May 30, 1980. Additional serum specimens were obtained four to eight weeks later from 33 persons who were identified at the May 30, 1980, clinic as having compatible symptoms and/or positive serologic tests.** Serum specimens obtained during August 1980 from 103 inpatients and outpatients at the local Pittsfield hospital were tested for fungal CF antibodies by the Illinois Department of Public Health Laboratory. Only the age and sex of these patients were recorded.

Five specimens of bat droppings from the school attic and four soil samples from the grounds immediately adjacent to the school building were collected May 30, 1980, and processed in an attempt to isolate *H. capsulatum.* An additional eight soil samples from the grounds immediately adjacent to the school building were again collected in May 1981. The livers and spleens of five bats captured in the attic on August 1980 were also cultured on brain-heart infusion agar and mycobiotic agar plates for isolation of *H. capsulatum.* Four cages of CF1 mice (four mice per cage) were exposed to the building during August 1980. Cages were left in the attic for four and 20 hours and on the first and second floors for 20 hours. The spleens from these mice were subsequently cultured.***

**Results**

Twenty people met the case definition. Twelve suspect cases were identified: nine had compatible symptoms but did not meet the serologic criteria, and three met the serologic criteria but did not have symptoms. Forty-two seronegative asymptomatic persons who had visited the building and three persons who had visited only the grounds immediately adjacent to the building were classified as exposed controls.

Dates of onset for cases and suspect cases are plotted in Figure 1. The symptoms they exhibited are shown in Table 1. Chest radiographs were available from 12 of the 20 cases. Radiographs from two patients were within normal limits, two showed small calcifications, four showed enlarged hilar lymph nodes, and eight showed a bilateral diffuse patchy and irregular pulmonary infiltration.

The results of CF titers are summarized in Table 2. Thirty per cent (23/77) of persons exposed to the building were seropositive, as defined by our serologic case definition, compared to 2 per cent (2/103) of the hospital comparison group (p < .001, by chi-square). Complement fixation tests for *C. immitis* were negative in all specimens tested. The results of immunodiffusion tests are summarized in

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*1* A CF titer of ≥ 1:32 for the yeast or mycelial antigen of *Histoplasma capsulatum* or *Blastomyces dermatitidis* or a seroconversion between acute phase and convalescent phase specimens for the M precipitin band by ID testing. One woman who refused serologic testing was included as a case on the basis of her strongly suggestive symptoms and chest radiograph findings.

**Complement fixation tests with the yeast-form and mycelial antigens of *H. capsulatum,* and the yeast-form antigens of *Blastomyces dermatitidis* and *Coccidioides immitis* were performed by the Illinois Department of Public Health Laboratories, Chicago, Illinois, and by the Mycology Division of the Centers for Disease Control, Atlanta, Georgia. All titers were reported as reciprocals. Immunodiffusion tests with antigens of *H. capsulatum, B. dermatitidis,* and *C. immitis* were also performed at these same two laboratories.

***All environmental specimens were processed by the Mycology Division of the Centers for Disease Control in Atlanta, Georgia. Mice were inoculated intraperitoneally with the supernatant from aqueous suspensions of the antibiotic treated specimens and their livers and spleens were subsequently cultured.

### TABLE 1—Histoplasmosis Symptoms, Pittsfield, Illinois, 1980

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Cases</th>
<th>Suspect Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fever</td>
<td>18</td>
<td>9</td>
</tr>
<tr>
<td>Malaise</td>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td>Cough</td>
<td>14</td>
<td>6</td>
</tr>
<tr>
<td>Chest pain</td>
<td>13</td>
<td>5</td>
</tr>
<tr>
<td>Chills</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Headache</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>Weight loss</td>
<td>9</td>
<td>—</td>
</tr>
<tr>
<td>Abdominal cramps</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Myalgia</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Sputum prod.</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Total ill</td>
<td>20</td>
<td>9</td>
</tr>
</tbody>
</table>

*3 Suspect Cases were asymptomatic.
Table 2. Distribution of Complement Fixation Titers Associated with an Outbreak of Histoplasmosis in Pittsfield, Illinois, 1980

<table>
<thead>
<tr>
<th>Cases (20)</th>
<th>Suspect Cases (12)</th>
<th>Exposed Controls (45)</th>
<th>Hospital Comparison Group (103)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>M</td>
<td>BL</td>
<td>Y</td>
</tr>
<tr>
<td>C</td>
<td>512</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>F</td>
<td>256</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>T</td>
<td>64</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>I</td>
<td>32</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>E</td>
<td>16</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>R</td>
<td>8</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>&lt;8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N.D.</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Y = Histoplasma Yeast Reciprocal
M = Histoplasma Mycelial Reciprocal Titer
BL = Blastomycosis Reciprocal Titer

Table 3. An M precipitin band was found in all 20 of the cases. Thirteen (81 per cent) of the 16 cases from whom a second serum specimen was available showed at least a fourfold difference in Histoplasma titer between the two serum specimens. Three of the suspect cases and none of the exposed controls had a detectable M band. Seven of the cases had a detectable H band in addition to the M band, while none of the suspect cases or exposed controls had detectable H bands.

There were 16 attic visitors among the clinic participants, eight of whom were later classified as cases. Six of the eight cases with attic exposure became ill five to 22 days (mean 13 days) after their exposure. The incubation periods for the other cases could not be accurately determined; in all instances, however, last visitation to the attic preceded onset of illness by less than one month.

The case attack rate was 15 per cent (8/54) for clinic participants who visited the first and/or second floors of the building between April 14 and May 16. This attack rate was significantly lower (p < .01, chi-square) than the 50 per cent attack rate for attic visitors. The eight cases with only first and second floor exposure from April 14 to May 17 spent a mean of 53 hours in the building, compared to 21 hours for the 36 responding exposed controls who were in the building but never in the attic. These hours of exposure were significantly different (p = .02, Student’s two-tailed t-test).

Three cases were children who played near the school almost every day. The father of two of these children was one of the school employees who became ill after working in the attic. He did not change his clothes after working in the attic before returning home. His two children became ill one and two days after their father. His wife had CF titers of 16 and an M band on ID, but was not ill and was never in the building. One of the cases was the garbage collector who had never entered the building but had handled material discarded from the building, including material the four workmen had discarded from the attic.

The five specimens of bat guano obtained from the attic, four soil samples from outside the building, and the livers and spleens of five bats captured in the attic in 1980 were all culture negative for H. capsulatum. However, two of the bat dropping specimens obtained from the attic grew Cryptococcus neoformans. Although some of the mice exposed to the building had visibly enlarged spleens, the cultures of these organs were also negative for Histoplasma. H. capsulatum was isolated from two of the soil samples taken in May 1981 from the ground under the hole in the eaves where the bats had been entering the attic. This location was approximately 10 meters from the playground.

Discussion

The number of persons with high histoplasmosis titers among those exposed to the Old East School is much greater than normal for this community. The high attack rate among clinic participants who were exposed to the attic, the epi-
demic curve following disturbance of the droppings, the association of illness with total hours of building exposure, and the appropriate incubation period following single attic exposures establish that the outbreak was associated with exposure to the bat droppings.

A search of the literature revealed other reports in which bat-infested buildings were implicated as the source of histoplasmosis. Like the Old East School, these buildings had been renovated after a period of abandonment. These outbreaks involved small, privately owned structures and resulted in a small number of human cases.

The first control measure was to lock and seal all access to the Old East School attic. The building was evacuated for decontamination and removal of the bat droppings after the existence of the outbreak had been established. One of the workmen, having recovered from his illness, entered the attic wearing overalls, rubber boots, gloves, hat, and a mask designed for biologic and chemical warfare. The bat droppings were thoroughly soaked with 4 per cent formalin solution on each of four consecutive days. On the fifth day, the droppings were shoveled into plastic garbage bags and buried. The bats were shot or scared away, and the hole under the eaves where they were entering the attic was sealed. Formalin vapors had dissipated sufficiently to allow occupancy of the building two days later.

The occurrence of this outbreak is significant in several respects. To our knowledge, this is the largest reported outbreak of histoplasmosis associated with a bat-infested building. It should provide a reminder of the public health hazard of bat infestation. The possibility of rabies transmission is another hazard of bat infestation. The epidemiologic investigation which implicated the droppings in the attic adds further credibility to the theory that bat droppings do not need to be mixed with soil to support the growth of Histoplasma. It also refutes the theory that Histoplasma cannot survive in hot, dry attics.

We have since learned of another outbreak of approximately 20 cases of acute pulmonary histoplasmosis associated with a bat-infested school building located in Iowa, approximately 100 miles from Old East School. Perhaps it is significant that the buildings involved in these other outbreaks and the Old East School had become infested with bats during a period of abandonment and had remained infested after the structures were reoccupied.

It is well established that H. capsulatum can grow in large numbers in bird and bat droppings, and is not ubiquitous to entire regions or countries. Rather, the organism is present in microenvironments that have been contaminated with bird or bat droppings. Disturbing bat or bird droppings has been implicated repeatedly in causing epidemics of histoplasmosis. Health departments and the medical community should be able to recognize the distinct ecologic niche conducive to H. capsulatum growth. Every human and animal case of histoplasmosis should be investigated with the purpose of locating a nidus of infection which was previously unknown. Once a Histoplasma microenvironment has been identified, health departments should assist communities with bat or bird control, recommendations to prevent infectious spores from becoming airborne, and, if necessary, formalin disinfection.

REFERENCES
16. Histoplasmosis Control: Decontamination of Bird Roosts, Chicken Houses, and Other Point Sources. Atlanta, GA: Centers for Disease Control.

ACKNOWLEDGMENTS
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†Personal communication from Dr. Nicholas Lerche.