No Evidence of a Mild Form of Inhalational *Bacillus anthracis* Infection During a Bioterrorism-Related Inhalational Anthrax Outbreak in Washington, D.C., in 2001

Henry C. Baggett,1,3,a Julia C. Rhodes,2,3 Scott K. Fridkin,4 Conrad P. Quinn,4 Jeffrey C. Hageman,5 Cindy R. Friedman,4 Clare A. Dykewicz,4 Vera A. Semenova,4 Sandra Romero-Steiner,4 Cheryl M. Elie,4 and John A. Jernigan5

1Arctic Investigations Program, National Center for Infectious Diseases, Centers for Disease Control and Prevention, Anchorage, Alaska; 2National Center for Health Statistics, Centers for Disease Control and Prevention, Hyattsville, Maryland; and 3Epidemic Intelligence Service, Division of Applied Public Health Training, 4Division of Bacterial and Mycotic Diseases and 5Division of Healthcare Quality Promotion, National Center for Infectious Diseases, Centers for Disease Control and Prevention, Atlanta, Georgia

**Background.** The mail-related dispersal of *Bacillus anthracis* spores in the Washington, D.C., area during October 2001 resulted in 5 confirmed cases of inhalational anthrax. We identified an additional 144 ill persons who were potentially exposed to aerosolized spores and whose symptoms were compatible with early inhalational anthrax but whose clinical course and nonserologic laboratory evaluation revealed no evidence for *B. anthracis* infection. We hypothesized that early antibiotic use could have decreased the sensitivity of diagnostic tests or that bioterrorism-related inhalational anthrax may include mild disease.

**Methods.** Eligible patients included those with illness compatible with early inhalational anthrax who had potential exposure to *B. anthracis*. Patient serum samples were tested for immunoglobulin G (IgG) antibody against *B. anthracis* protective antigen (PA) using a sensitive enzyme-linked immunosorbant assay (sensitivity, 97.6%).

**Results.** Of the 144 eligible patients, 66 (46%) had convalescent-phase serum samples available for testing; 29 (44%) worked in an area considered to pose a high risk of exposure to *B. anthracis* spores. Of the 37 patients who worked in areas that did not meet the definition of high-risk exposure, 23 (62%) worked in United States postal or other government facilities in which exposure was plausible but not documented. None of the 66 patients with convalescent-phase serum samples showed evidence of an anti-PA IgG serologic response to *B. anthracis*.

**Conclusions.** These data suggest that a mild form of inhalational anthrax did not occur and that surveillance for moderate or severe illness was adequate to identify all inhalational anthrax cases resulting from the Washington, D.C., bioterrorism-related anthrax exposures.

During October and November 2001, *Bacillus anthracis* spores sent through the United States mail resulted in 22 confirmed cases of anthrax. Eleven of these patients had inhalational anthrax, and 5 (45%) died [1]. Part of this outbreak was located in the Washington, D.C., metropolitan area, where 5 confirmed cases of inhalational anthrax and 2 inhalational anthrax deaths occurred. All 5 patients with confirmed inhalational anthrax had severe illnesses that were clinically compatible with published descriptions of inhalational anthrax disease [2–4]. Inhalational anthrax was confirmed in these patients shortly after presentation by isolation of *B. anthracis* from blood culture or by positive results of immunohistochemical staining of *B. anthracis* antigens in samples of tissue or body fluid [5, 6]. Enhanced case finding in Washington, D.C., also identified patients who had been potentially exposed to *B. anthracis* spores and who developed mild illnesses that were initially compatible with early inhalational anthrax but whose subsequent clinical course and nonserologic laboratory evaluation revealed no evidence for *B. anthracis* infection.

Inhalational anthrax classically begins as a nonspecific illness with fever, myalgias, nonproductive cough,

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Present affiliation: Centers for Disease Control and Prevention, Atlanta, Georgia.

Reprints or correspondence: Dr. Henry C. Baggett, CDC, Div. of Global Migration and Quarantine, MS-E03, 1600 Clifton Rd., Atlanta, GA 30333 (hbaggett@cdc.gov).

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and malaise, which abruptly progresses to respiratory failure, sepsis, and death [2–4]. Focusing bioterrorism-associated anthrax surveillance on identifying severely ill persons implies that all patients with inhalational anthrax infection develop severe disease. However, a 1957 study found that 11 (15%) of 72 asymptomatic mill workers with probable repeated exposure to aerosolized *B. anthracis* spores were seropositive for IgG by agar diffusion testing, suggesting that they may have had unrecognized *B. anthracis* infection [7].

We postulated that the clinical spectrum of bioterrorism-related inhalational anthrax could include a mild illness, either as part of the natural history of the disease or as the result of antibiotic use very early in the course of infection. Antibiotic use was common among potentially exposed persons during this outbreak, either as postexposure prophylaxis (PEP) or as early presumptive treatment. Early treatment of infected patients could have decreased the sensitivity of clinical culture or attenuated the course of illness so that a diagnosis of *B. anthracis* infection was missed.

In 2001, Swartz [8] suggested that serologic tests for antibodies to *B. anthracis* may help public health authorities to diagnose possible subclinical anthrax cases. A newly developed ELISA for IgG antibody against *B. anthracis* protective antigen (PA) (anti-PA IgG) was rapidly adapted and validated for clinical use during the 2001 anthrax bioterrorism attack investigations [9]. The objective of this investigation was to use this new ELISA serologic test to seek evidence of *B. anthracis* infection among potentially exposed patients with mild illness during the 2001 bioterrorism-related anthrax outbreak in Washington, D.C. We also compared symptoms of all patients with confirmed inhalational anthrax cases to those of ill persons reported to the Washington, D.C., Clinical Investigation Team (CIT) who had test results negative for *B. anthracis* infection.

**METHODS**

**Patients.** The cohort consisted of patients with cases of disease reported to the CIT from 21 October to 3 November 2001. The CIT conducted active and passive surveillance to identify ill persons in the Washington, D.C., area with possible inhalational anthrax. We defined a possible case as illness with symptoms compatible with early inhalational anthrax (e.g., cough, dyspnea, myaligias, fever) in a person who had been exposed to an area where *B. anthracis* spore contamination was plausible according to the treating physician and the CIT. The CIT monitored the patient's clinical course until anthrax disease was excluded or confirmed. A confirmed case of inhalational anthrax was defined as a clinically compatible illness that was...
confirmed by isolation of *B. anthracis* or by other laboratory evidence of *B. anthracis* infection on the basis of the results of \( \geq 2 \) supportive nonserologic laboratory tests [10]; other cases were not considered to be cases of inhalational anthrax, and patients with such cases were defined as non–case patients. Reports of possible cutaneous anthrax disease were not included in this evaluation.

We requested reports of possible cases of anthrax from the Maryland, Virginia, and Washington, D.C., Departments of Health, as well as the Office of the Attending Physician at the U.S. Capitol in Washington, D.C. Local health departments in Washington, D.C., and nearby areas of Maryland and Virginia instituted active anthrax surveillance in local emergency departments, intensive care units (ICUs), and clinical laboratories, which were asked to fax daily patient logs to their respective local health departments and to report any patients with illness consistent with inhalational anthrax disease. Clinical labora-

torians were asked to report all isolates of large gram–positive rods (1–1.5 \( \times \) 3–5 \( \mu m \)) to the local health department. Anthrax surveillance was facilitated by the emergency department–based enhanced syndromic surveillance network established by health departments in the Washington, D.C., area to detect bioterrorism-related illnesses after the terrorist attacks of 11 September 2001. A CIT telephone hotline was established to facilitate reporting.

Patients were excluded from the cohort of those with possible inhalational anthrax cases if they had no apparent epidemiologic link to any places where *B. anthracis* spores had been identified [11] and did not work for the US Postal Service or another US government agency. Exceptions were made for patients whose clinical findings were highly suggestive of inhalational anthrax, including patients with abnormal findings on chest radiographs or CT scans, suspected meningitis, or documented fever and dyspnea.

**Exposure assessment.** CIT members conducted scripted telephone interviews of the cohort of patients with possible inhalational anthrax to assess the potential risk for *B. anthracis* spore exposure at the workplace. We assessed potential exposures outside of the workplace, including visits to areas with known *B. anthracis* spore contamination, recent travel outside of the United States, and exposure to farm or game animals. We asked about concurrent illnesses, past military duty, previous anthrax vaccination, and the recent use of antibiotics (including PEP). When patients could not be reached for an interview, their potential *B. anthracis* spore exposure was assessed by proxy from our interview of their physicians.

Persons were considered to be at high risk for exposure if they worked in or visited an area with *B. anthracis* spore contamination that warranted a Centers for Disease Control and Prevention (CDC) recommendation for a full course of PEP [11]. These high-risk exposure areas were defined by “1) the presence of an inhalational case at a facility, 2) environmental specimens positive for *B. anthracis* in facilities along the path of a contaminated letter in which aerosolization might have occurred, and 3) exposure to an air space known to be contaminated with aerosolized *B. anthracis* from an opened letter” [11, pp. 1008–9].

**Clinical data.** The CIT collected clinical details on possible cases of inhalational anthrax by interviewing reporting physicians and nurses by telephone with use of a standard form. We collected available clinical information and laboratory results, but we did not routinely request specific test results or review patients’ medical records. Radiologists’ interpretations of chest radiographs and CT scans were recorded.

**Serologic evaluation.** Acute-phase serum samples were obtained from patients during the 1–14-day period after onset of the patients’ symptoms. Convalescent-phase serum samples were obtained during the 15–60-day period after onset of symptoms and at least 7 days after collection of acute-phase serum samples. We attempted to contact all of the patients in the cohort by telephone at least 3 times to make appointments for collection of convalescent-phase serum samples and sent letters to persons whom we could not reach by telephone. We made extra efforts (i.e., additional phone calls, letters, and home visits) to contact patients with severe disease, as suggested by abnormal chest radiograph or CT scan findings or by performance of a lumbar puncture. We also made increased efforts to contact patients who worked where *B. anthracis* spore aerosolization had been documented [11]. Because a single acute-phase serum IgG measurement is difficult to interpret, particularly when the result is negative, our analysis focused on patients with a convalescent-phase serum sample tested for anti-PA IgG.

All serum samples were tested at CDC for anti-*B. anthracis* PA IgG with an ELISA using immobilized, recombinant PA (rPA) to quantify serum anti-PA IgG antibodies [9]. Serum anti-PA IgG concentrations \( \geq 3.0 \) \( \mu g/mL \) can be quantified using the ELISA. The sensitivity of the assay is 97.6% and the specificity is 94.2% using 3.0 \( \mu g/mL \) as the cutoff value for a positive test result. For samples with IgG concentrations \( \geq 10 \) \( \mu g/mL \), a second-stage competitive inhibition (CI) ELISA was performed. The CI ELISA quantifies the suppression of rPA–specific binding by the patient’s IgG and improves the specificity of the original ELISA to 100% [9]. Patient serum samples that are highly suppressive (i.e., those that have \( > 85\% \) reduction in reported signal) are considered to contain IgG that is specific for *B. anthracis* PA.

This investigation was conducted as part of the public health response to the anthrax outbreak and was determined to be exempt from institutional review board review. Verbal informed consent was obtained for all telephone interviews, and written informed consent was obtained before collecting convalescent-phase serum samples.
RESULTS

Patients. The CIT received reports concerning 154 patients who were evaluated for possible inhalational anthrax during the period 21 October–3 November 2001. Five of these patients had inhalational anthrax confirmed by blood culture, and their serologic test results and clinical presentations were reported elsewhere [5, 12, 13]. Another 5 patients whose cases were reported to the CIT were excluded from the cohort of those with possible inhalational anthrax cases, because they had neither any link to areas with known spore contamination nor symptoms that were consistent with inhalational anthrax.

Exposure assessment. Of the remaining 144 eligible patients, 56 (39%) worked in an area considered to pose a high risk of exposure to B. anthracis spores; 29 (52%) of these patients had convalescent-phase serum samples available for testing, including 22 with both acute-phase and convalescent-phase samples (figure 1). Eighty-eight (61%) of the 144 eligible patients did not work in areas where epidemiologic and environmental findings prompted a CDC PEP recommendation, and therefore, they did not meet the definition of being at high risk for B. anthracis spore exposure; 37 (42%) of these patients had convalescent-phase serum samples available for testing, including 27 with both acute-phase and convalescent-phase samples. Of note, 23 (62%) of 37 persons who did not meet the definition for being at high risk of exposure worked in US postal or other government facilities where there was potential for exposure, but the risk was unknown at the time of CIT referral.

A total of 33 patients had only acute-phase serum specimens available, and of these, only 1 patient had a detectable anti-PA IgG concentration (5.8 µg/mL); this patient’s specimen was collected on the fifth day of illness, and the concentration was too low for CI ELISA testing (i.e., <10 µg/mL). The remaining analysis focuses on the 66 patients who had convalescent-phase serum samples collected, hereafter referred to as the serologic study group. Among the 29 patients in the serologic study group who were considered to be at high risk for spore exposure, 22 (76%) were receiving PEP when they presented for evaluation, compared with 11 (30%) of 30 patients who were not in the high-risk group.

Clinical data. The median age of the 57 patients of known age in the serologic study group was 44 years (range, 22–70); 33 (50%) of the 66 patients were female. Similarly, the median age of the 29 patients at high risk for B. anthracis exposure was 43 years; 55% of these patients were female. The most common symptoms were fever and/or chills (52%), nonproductive cough (41%), and myalgias (41%), and the frequency of symptoms did not differ by risk of spore exposure (table 1).

Chest radiographs were obtained for 64 (97%) of the 66 patients in the serologic study group, and results were similar within each exposure-risk category (table 2). Six patients had abnormal chest radiograph findings; 1 patient had a widened mediastinum, 3 had pulmonary infiltrates, and 2 had “possible” pleural effusions. Chest CT scans were performed for 33 (50%) of the 66 patients, and 8 (24%) had abnormal findings; 6 persons had mediastinal lymphadenopathy or widening, 1 person had a pulmonary infiltrate, and 1 person had a granuloma (table 2).

The clinical details for the 6 patients with chest CT findings indicative of possible mediastinal widening/lymphadenopathy are as follows. Patient 1 was a 53-year-old man with a discharge diagnosis of congestive heart failure. Patient 2 was a 58-year-old man with a discharge diagnosis of unstable angina. Patient 3 was a 50-year-old man with a discharge diagnosis of “clinical illness warranting further investigation.” Patient 4 was a 23-year-old man with no specific discharge diagnosis listed. Patient 5 was a 53-year-old man with no specific discharge diagnosis listed. Patient 6 was a 55-year-old man with a diagnosis of possible malignancy.

WBC counts were known for 52 (79%) of the 66 patients in the study group. Seven patients had a WBC count outside of the normal range for adults (normal range, 4.5–10.0 × 10³ cells/mm³), 3 of whom were in the high-risk exposure group; 1 patient had a WBC count of 2.9 × 10³ cells/mm³, and 6 patients had WBC counts of >10.0 × 10³ cells/mm³ (range, 11.8–18.0 × 10³ cells/mm³).

Table 1. Comparison of symptoms for 66 patients in the serologic study group with symptoms for 11 patients with confirmed cases of inhalational anthrax (case patients), Washington, D.C., 2001.

<table>
<thead>
<tr>
<th>Symptom(s)</th>
<th>Serologic study group</th>
<th>Case patients</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>At high risk for B. anthracis spore exposure</td>
<td>Not at high risk for B. anthracis spore exposure</td>
</tr>
<tr>
<td>Fever and/or chills</td>
<td>15 (52)</td>
<td>19 (50)</td>
</tr>
<tr>
<td>Nonproductive cough</td>
<td>12 (41)</td>
<td>15 (41)</td>
</tr>
<tr>
<td>Myalgias</td>
<td>12 (41)</td>
<td>15 (41)</td>
</tr>
<tr>
<td>Fatigue and/or malaise</td>
<td>9 (31)</td>
<td>14 (38)</td>
</tr>
<tr>
<td>Chest pain</td>
<td>8 (28)</td>
<td>12 (32)</td>
</tr>
<tr>
<td>Dyspnea</td>
<td>0</td>
<td>13 (35)</td>
</tr>
<tr>
<td>Sweats</td>
<td>5 (17)</td>
<td>4 (11)</td>
</tr>
<tr>
<td>Nausea or vomiting</td>
<td>…</td>
<td>…</td>
</tr>
<tr>
<td>Any symptom</td>
<td>26 (90)</td>
<td>34 (92)</td>
</tr>
</tbody>
</table>

NOTE. Symptoms considered to be absent if data were missing. Symptoms for 11 patients with confirmed cases of inhalational anthrax are from [5] and [14]. B. anthracis, Bacillus anthracis.

- Exposure to an area with B. anthracis spore contamination warranting a Centers for Disease Control and Prevention recommendation of 60 days post-exposure antibiotic prophylaxis against anthrax [11].
- Symptoms for the remaining 6 patients were not well documented; 2 patients had nonspecific symptoms, such as headache and productive cough, and 4 patients had incomplete clinical information.
Table 2. Chest radiograph and CT scan findings for patients in the serologic study group, by risk of Bacillus anthracis exposure, Washington, D.C., 2001.

<table>
<thead>
<tr>
<th>Radiologist interpretation</th>
<th>High-risk group (n = 29)</th>
<th>Non–high risk group (n = 37)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chest radiograph findings</td>
<td>29 (100)</td>
<td>16 (55)</td>
</tr>
<tr>
<td>Chest CT findings</td>
<td>16 (55)</td>
<td>17 (46)</td>
</tr>
<tr>
<td>Any findings</td>
<td>29 (100)</td>
<td>35 (95)</td>
</tr>
<tr>
<td>Abnormal findings</td>
<td>16 (55)</td>
<td>17 (46)</td>
</tr>
<tr>
<td>Any</td>
<td>2 (7)</td>
<td>4 (11)</td>
</tr>
<tr>
<td>Possible pleural effusion</td>
<td>0</td>
<td>1 (3)</td>
</tr>
<tr>
<td>Pulmonary infiltrate</td>
<td>0</td>
<td>2 (6)</td>
</tr>
<tr>
<td>Wide mediastinum/mediastinal lymphadenopathya</td>
<td>0</td>
<td>1 (3)</td>
</tr>
<tr>
<td>Granuloma</td>
<td>0</td>
<td>1 (6)</td>
</tr>
</tbody>
</table>

NOTE. The high risk group included those with exposure to an area with B. anthracis spore contamination warranting a CDC recommendation of 60 days postexposure antibiotic prophylaxis against anthrax [11]. The non–high risk group included those without such exposure.

a The clinical details for the 6 patients with chest CT findings indicative of possible mediastinal widening/lymphadenopathy are as follows. Patient 1 was a 53-year-old man with a discharge diagnosis of congestive heart failure. Patient 2 was a 58-year-old man with a discharge diagnosis of unstable angina. Patient 3 was a 50-year-old man with a discharge diagnosis of “clinical illness warranting further investigation.” Patient 4 was a 23-year-old man with no specific discharge diagnosis listed. Patient 5 was a 53-year-old man with no specific discharge diagnosis listed. Patient 6 was a 55-year-old man with a diagnosis of possible malignancy.

Serologic evaluation. Five (7.6%) of the 66 patients in the serologic study group had at least 1 serum specimen with anti-PA IgG concentrations greater than the lower limit of quantification of the ELISA (i.e., ≥3.0 μg/mL); 2 of these patients were considered to be at high risk for B. anthracis exposure (table 3). Four of these patients had acute-phase serum samples that were available for testing, and all 4 acute-phase concentrations were too low for CI ELISA testing (i.e., <10 μg/mL); only 1 patient had an increase in antibody concentration between the acute phase and the convalescent phase (from 5.3 μg/mL to 19.8 μg/mL), but the convalescent-phase specimen showed no suppression in rPA binding activity, indicating that reactivity was not due to specific anti-PA antibodies. One patient had a single convalescent-phase serum sample that had a quantifiable antibody concentration of 11.7 μg/mL, but CI ELISA testing of this sample showed that the antibody detected was not anti-PA specific. Therefore, 0 of 29 patients in the high-risk exposure group (95% CI, 0%–11.9%), and 0 of 37 patients who were not in the high-risk group (95% CI, 0%–5.4%) showed evidence of an anti-PA IgG serologic response to B. anthracis.

Comparison of symptoms between patients with confirmed inhalational anthrax cases and non–case patients. Among the 11 patients with confirmed cases of inhalational anthrax, the most common symptoms were fever and/or chills (in 100% of patients), malaise (100%), nonproductive cough (91%), nausea and/or vomiting (82%), and dyspnea (82%) [5, 14]. Sixty (91%) of the 66 patients in our serologic study group (i.e., the non–case patients) had at least 1 of these 5 symptoms at presentation, but each symptom was much less common among

Table 3. Antibody to protective antigen (anti-PA IgG) levels for 5 patients in the serologic study group with at least 1 reactive serum sample.

<table>
<thead>
<tr>
<th>Patient</th>
<th>High risk for Bacillus anthracis exposurea</th>
<th>Anti-PA IgG level, μg/mL</th>
<th>Acute-phase serum sample</th>
<th>Convalescent-phase serum sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>No</td>
<td>3.1</td>
<td>&lt;3.0</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Yes</td>
<td>8.0</td>
<td>8.0</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Yes</td>
<td>7.5</td>
<td>8.5</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>No</td>
<td>5.3</td>
<td>19.8c</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>No</td>
<td>NA</td>
<td>11.7c</td>
<td></td>
</tr>
</tbody>
</table>

NOTE. A reactive serum sample was defined as one with an anti-PA IgG level of ≥3.0 μg/mL (lower limit of quantification, 3.0 μg/mL). NA, not available.

a Exposure to an area with B. anthracis spore contamination warranting a Centers for Disease Control and Prevention recommendation of 60 days post-exposure antibiotic prophylaxis against anthrax [11].

b Patient B reported receiving the anthrax vaccine during military service years earlier.

c Results of competitive inhibition ELISA testing performed for the 2 specimens with anti-PA levels >10.0 μg/mL showed no suppression, indicating that reactivity in these samples was not due to specific anti-PA antibodies.
DISCUSSION

We sought to enhance case finding by seeking serologic evidence of \textit{B. anthracis} infection among persons who were potentially exposed to aerosolized spores and who subsequently developed symptoms compatible with early inhalational anthrax but whose clinical progression and laboratory evaluation were nondiagnostic for anthrax. With use of a serologic assay with very high sensitivity (>97%) and specificity (>94%) [9], we did not identify any cases of previously undiagnosed \textit{B. anthracis} infection in this population. Our findings support that all inhalational anthrax cases that occurred during the 2001 bioterrorism-related outbreak in the Washington, D.C., area were identified through recognition of typical clinical presentations and the use of nonserologic laboratory tests, such as culture, immunohistochemical analysis, and PCR [5, 6, 15].

We found no evidence that bioterrorism-related inhalational anthrax results in mild disease. During the 2001 anthrax attack, all 11 patients with documented inhalational anthrax had severe, progressive illness requiring hospitalization [5, 14]. Studies performed before the 2001 outbreak suggested that subclinical infection might occur in animals following exposure to \textit{B. anthracis} spores [16]. A 1957 serologic survey of asymptomatic workers in a goat-hair processing mill revealed that 15% of those tested were seroreactive to the \textit{B. anthracis} protective antigen [7]; although these serologic test results may have resulted from previously unrecognized or unreported mild inhalational anthrax, other possible explanations include unrecognized or unreported cutaneous anthrax, immunization from nonviable spores, or false-positive assay reactions. Findings from 2 serologic studies conducted during the 2001 Washington, D.C., anthrax investigation provide no evidence for asymptomatic infection following exposure to aerosolized \textit{B. anthracis} spores [15, 17]. These findings, in combination with those of our study, suggest that surveillance during future bioterrorism-related inhalational anthrax outbreaks should target exposed persons with moderate-to-severe illness.

Our findings suggest that lack of illness progression argues strongly against the diagnosis of inhalational anthrax, even among patients who begin antibiotic therapy soon after symptom onset. Among the 11 patients with confirmed inhalational anthrax during the 2001 outbreak, 2 had antimicrobial therapy started within 48 h after symptom onset, and although these patients survived, their therapy did not prevent progression to severe illness [5]. Therefore, those who fail to demonstrate progression of symptoms after 48–72 h are unlikely to have inhalational anthrax.

There are several limitations to this investigation. The study group consisted of patients referred to the CIT by area health care professionals and may have missed some ill, exposed patients who did not seek health care or whose treating physician did not contact the CIT. However, intense media coverage and heightened surveillance at area hospitals and high-risk work places make it unlikely that symptomatic patients with epidemiologic links to the investigation were not reported to the CIT. A second limitation was incomplete patient follow-up, because we only obtained convalescent-phase serum samples from 52% (29 of 56 patients) of those at high risk for spore exposure and from 42% (37 of 88 patients) of those not considered to be at high risk. In patients with confirmed inhalational anthrax, serum anti-PA IgG antibodies are not quantifiable until at least 11 days after symptom onset [12], rendering a negative acute-phase serum IgG result without a paired convalescent-phase serum IgG result uninterpretable. Finally, it is possible but unproved that some patients in our study group had a subclinical anthrax infection with an IgG immune response that was abrogated because of early treatment with antibiotics. However, antibiotic therapy did not suppress the IgG response in 16 of 17 patients with confirmed or suspected cutaneous or inhalational anthrax related to the 2001 anthrax attack [12]. The seventeenth patient with confirmed anthrax in that series had cutaneous anthrax that was treated with antibiotics within 2 days after symptom onset and did not have anti-PA IgG antibodies detected in acute-phase or convalescent-phase serum samples. There was no evidence to suggest that antibiotic therapy suppressed the anti-PA IgG response among patients with inhalational anthrax. Cutaneous anthrax may produce a much lower systemic PA exposure than inhalational anthrax, causing a lower or undetectable anti-PA IgG and immune memory response [12].

Our study failed to identify evidence of \textit{B. anthracis} infection among mildly ill, potentially exposed patients during a bioterrorism-related anthrax outbreak. These findings, along with other serologic surveys [15, 17], support the conclusion that mild or asymptomatic inhalational anthrax does not occur. Routine serologic surveys among exposed persons with no or only mild illness are unlikely to enhance inhalational anthrax case finding during an anthrax outbreak.

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