

Anthrax Exposure, Belief in Exposure, and Postanthrax Symptoms Among Survivors of a Bioterrorist Attack on Capitol Hill

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ABSTRACT

Background: Following chemical, biological, radiological, and nuclear disasters, medically unexplained symptoms have been observed among unexposed persons.

Objectives: This study examined belief in exposure in relation to postdisaster symptoms in a volunteer sample of 137 congressional workers after the 2001 anthrax attacks on Capitol Hill.

Methods: Postdisaster symptoms, belief in exposure, and actual exposure status were obtained through structured diagnostic interviews and self-reported presence in offices officially designated as exposed through environmental sampling. Multivariate models were tested for associations of number of postdisaster symptoms with exposure and belief in exposure, controlling for sex and use of antibiotics.

Results: The sample was divided into 3 main subgroups: exposed, 41%; unexposed but believed they were exposed, 17%; and unexposed and did not believe that they were exposed, 42%. Nearly two-thirds (64%) of the volunteers reported experiencing symptoms after the anthrax attacks. Belief in anthrax exposure was significantly associated with the number of ear/nose/throat, musculoskeletal, and all physical symptoms. No significant associations were found between anthrax exposure and the number of postdisaster symptoms.

Conclusions: Given the high incidence of these symptoms, these data suggest that even in the absence of physical injury or illness, there may be surges in health care utilization. (*Disaster Med Public Health Preparedness*. 2019;13:555-560)

Key Words: bioterrorism, medically unexplained symptoms, anthrax, disaster, belief in exposure

The events of September 11, 2001, and the persistent threat of terrorism since then have prompted concerns about the ability of health care systems to respond to surges of casualties after such events. Studies on surge capacity have focused on the ability of health care systems to manage acute medical needs. Less attention has been given to uninjured or unexposed individuals who present with concerns about their health and/or physical symptoms after a terrorist incident. Large numbers of these individuals could potentially overwhelm the capacity of health care systems and divert needed resources from the care of injured individuals.

Bioterrorist attacks, like other incidents involving chemical, biological, radiological, and nuclear (CBRN) agents, differ from other forms of terrorism by being particularly fear-invoking. Bioterrorism typically involves a period of uncertainty about exposure to the harmful substance. The uncertainty regarding exposure to the harmful substance and the dreaded sequelae of serious disease can lead to

perceptions of high threat to personal health.¹ Prior studies demonstrated that for every individual who is exposed to or injured by an infectious or CBRN agent, a large number of unexposed and uninjured individuals present with concerns related to potential exposure and/or physical symptoms that cannot be directly attributed to the harmful substance. During the 1995 Tokyo subway sarin attacks,^{2,3} the unexposed patients who presented to Tokyo hospitals and clinics exceeded the patients with an actual exposure by a ratio of greater than 4 to 1. After a radioactive substance in Goiania, Brazil, contaminated 249 people in 1987, 125 000 patients self-presented for contamination checks.⁴ Approximately 1 out of 12 of these people reported symptoms of acute radiation sickness without evidence of contamination.⁵⁻⁷ These large numbers of concerned but uninjured individuals created an acute surge that burdened the health care response system.

Medically unexplained symptoms in disaster-exposed populations have been referred to as “somatization”

symptoms; however, such symptoms have been found to be unrelated to somatization disorder, which is a serious lifelong psychiatric illness.⁸ Outside of the construct of somatization disorder, these medically unexplained symptoms may be normative, and the patients who have them have been called “the worried well.” The term “worried well” has no universal definition and has been applied to patients with medically unexplained symptoms and patients with minor symptoms.^{3,9} Worried well populations have been observed in different clinical settings, including HIV-negative individuals who present to AIDS counseling centers;^{10,11} cognitively normal individuals who present at memory clinics;¹² and high-utilizers of primary care services.^{9,13} Basic characteristics of some of these populations have been described, including demographic data, associated psychiatric conditions, and measures of medical literacy, but data are limited, and proposed strategies for their management are based on expert opinion rather than empirical research. Worried well populations have also been identified in relation to disasters, including the Goiania incident,^{4,7} the Tokyo Sarin attacks,³ and the anthrax attacks.² Different kinds of worried well subgroups have been identified in relation to a single disaster, and explanations for worried well behavior have been proposed, with key factors including the actions of government authorities, public health officials, and the media; the nature of the symptoms associated with exposure; and risk perception, an individual’s subjective assessment of a hazard’s threat to personal health and well-being. Similar to nondisaster populations, there is still much to learn about these heterogeneous populations and how best to characterize their symptoms and manage their care from a public health and clinical perspective.

The anthrax attacks on Capitol Hill shortly after the September 11 attacks provided opportunities to observe and investigate the population of uninjured and unexposed individuals in the vicinity of the attack. Much of the research on bioterrorist attacks has focused on psychiatric disorders such as posttraumatic stress disorder (PTSD);¹⁴ therefore, less is known about medically unexplained symptoms that may arise after a bioterrorist incident. In a focus group study of Capitol Hill workers after the anthrax attacks, uninjured and unexposed participants described physical symptoms arising after the anthrax attacks that made them wonder if they were infected with anthrax.¹⁵ To further characterize these symptoms, this quantitative study examined physical symptoms and their relation to actual exposure and belief in exposure in a sample of 137 Capitol Hill congressional staff workers after the anthrax attacks.

METHODS

Greater detail of the methods used in this study is available in a previous publication.¹⁶ Permission to conduct the study was granted by the congressional offices of the participants. The study was approved by the Washington University School of

Medicine Institutional Review Board, and all study participants provided written informed consent. Participants (N = 137) represented a volunteer sample of congressional office workers from 43 Capitol Hill offices (29 Senate offices, 12 House offices, and 2 non-Senate, non-House capitol offices) recruited through notices, a newsletter, and word of mouth. Half (n = 37) of the 70 staff workers in the 2 most highly exposed offices participated in the study, ensuring a high representation of exposed members in the sample. Capitol Hill health officials orchestrated systematic nasal swab testing for anthrax and initiated antibiotic prophylaxis for individuals known to be in areas of exposure or potential exposure.

The Diagnostic Interview Schedule for DSM-IV (DIS-IV)¹⁷ and the Disaster Supplement¹⁸ were administered 7 months after the anthrax attacks. These instruments provided assessment of diagnostic criteria for PTSD and major depression, both before and after the disaster, as well as specific disaster-related experiences. Participants’ anthrax exposure status was determined by their self-reported presence in offices that were later officially designated as exposed through environmental sampling. Participants were also asked whether they believed they had been exposed to anthrax in the attacks.

Postdisaster symptoms were queried through 2 sets of symptom questionnaires. The first set consisted of 48 symptoms based on a written symptom questionnaire used in a previous study of Gulf War veterans from a registry of veterans who believed they had Gulf-War related illnesses.¹⁹ These symptoms were scored positive only if (a) they were persistent or recurrent and (b) they were new or worsened after the disaster. The second set consisted of a list of 16 symptoms, and the symptoms were scored positive if the individual endorsed the symptom and attributed it to anthrax exposure. The symptoms comprising this list were derived from established symptom presentations of anthrax disease and from symptoms described by survivors of the Capitol Hill anthrax attacks in focus groups.¹⁵ Even though the mode of inquiry into symptoms differed in the 2 sets of symptoms questionnaires (new or worsened symptoms after the disaster versus symptoms attributed by the individual to anthrax infection), 12 of the 16 symptoms in the second set were also included in the first set.

Data from these 2 sets of symptom questionnaires were aggregated into a single combined list of 52 symptoms to maximize symptom data for analysis and to capture not only anthrax-attributed symptoms but also any incident or worsened symptoms after the anthrax attacks. For symptoms endorsed in both sets of questions, only 1 positive response was counted for the symptom. Combining these 2 sets of symptoms allowed participants to be reminded of symptoms that they had specifically attributed to anthrax, as well as other potential anthrax-related symptoms that they might not

necessarily have associated with anthrax. This combined collection of symptoms demonstrated good internal reliability (Cronbach $\alpha=0.89$). The 52 symptoms in the combined list were organized into organ systems: eyes/nose/throat (ENT), cardiovascular, gastrointestinal (GI), musculoskeletal (MSK), skin, neurologic, and psychological. In addition to these organ-system categories, a pain group was created, which included the pain-related symptoms from the GI, MSK, and neurologic categories. A combined physical symptoms group was also created, which included all symptoms that did not fall into the psychological group. Finally, an “all symptoms” variable was created, which included all 52 symptoms in the combined list.

Multivariate linear regression models were created to predict post disaster symptoms (dependent variable, 1 for each model) from either exposure (first model) or belief in exposure (second model), controlling for sex, prophylactic antibiotic use, disaster-related PTSD, and postdisaster major depression. Separation of anthrax exposure (among those who believed they had anthrax exposure) and belief in exposure (among those unexposed) into 2 separate models was needed to address variance inflation >1.8 in these models. The level of significance was set as $\alpha \leq 0.05$.

RESULTS

Study participants were 56% (n = 77) female, young (mean [SD] = 32.6 [10.3] years old), 88% Caucasian, and educated (mean [SD] = 16.9 [2.2] years). Three-fourths (74%, n = 101) of the participants received prophylactic antibiotics. As shown in Figure 1, fewer than half (41%, n = 56) of the participants were anthrax-exposed, and more than half (55%, n = 76) believed they had been exposed. Exposure and belief in exposure were significantly associated ($\chi^2 = 53.59, df = 1, P < .001$), but the correspondence between the two was not

complete. Of those exposed, 93% (n = 52) believed they were exposed, and 30% (n = 24) of the unexposed believed they were exposed. Therefore, there were 3 main subgroups of participants—41% (n = 57) who were exposed, 17% (n = 24) who were unexposed but believed they were exposed, and 42% (n = 57) who were unexposed and did not believe they were exposed. No demographic variables were associated with exposure or belief in exposure. Among the unexposed, significantly more men (43%, n = 16) than women (18%, n = 8) believed they were exposed ($\chi^2 = 6.05, df = 1, P = .014$).

More than half (53%, n = 73) of the participants reported at least 1 physical symptom. Psychological symptoms were reported by 43% (n = 59) of the participants and constituted one-third (n = 172) of all symptoms reported. Women reported a significantly higher number of all symptoms than did men (mean [SD]: 4.3 [5.4] vs 2.0 [3.3]; $t = 3.13, df = 128, P = .002$). Nearly two-thirds (64%, n = 87) of the participants reported experiencing any symptoms after the anthrax attacks, and on average, participants endorsed a mean (SD) = 3.3 (4.7) number of symptoms, ie, an average of 6% of all 52 symptoms on the combined list. The total number symptoms was higher on average among the exposed than the unexposed (mean [SD]: 5.1 [5.6] vs 2.1 [3.6]; $t = -3.56, df = 85, P < .001$). Only 18% (n = 25) of the participants reported symptoms that they attributed to anthrax infection (25% [n = 14] in the exposed group and 13% [n = 11] in the unexposed group, a nonsignificant difference), endorsing a mean (SD) of 0.3 (0.7) symptoms, ie, averaging 2% of the anthrax-attributed symptom list.

Table 1 presents a series of multivariate models (1 for each table row) comparing number of symptoms in each symptom group (dependent variable, 1 for each model) with belief in anthrax exposure among those unexposed (independent variable), controlling for demographic and diagnostic variables and antibiotics (independent covariates). In these models, belief in anthrax exposure was significantly associated with the number of ENT, MSK, and all physical symptoms, but not with psychological symptoms. (Even without disaster-related psychiatric disorders in the models, belief in anthrax was not associated with psychological symptoms.) Postdisaster major depression was positively associated with the number of skin symptoms, and antibiotics were positively associated with number of psychological symptoms.

Table 2 presents a series of multivariate models (1 for each table row) comparing number of symptoms in each symptom group (dependent variable, 1 for each model) with anthrax exposure among those who believed they were exposed (independent variable), controlling for demographic and diagnostic variables and antibiotics (independent covariates). In these models, no significant associations were found between anthrax exposure and total number of postdisaster symptoms or number of symptoms in any symptom group. Neither anthrax exposure nor belief in exposure among those

FIGURE 1

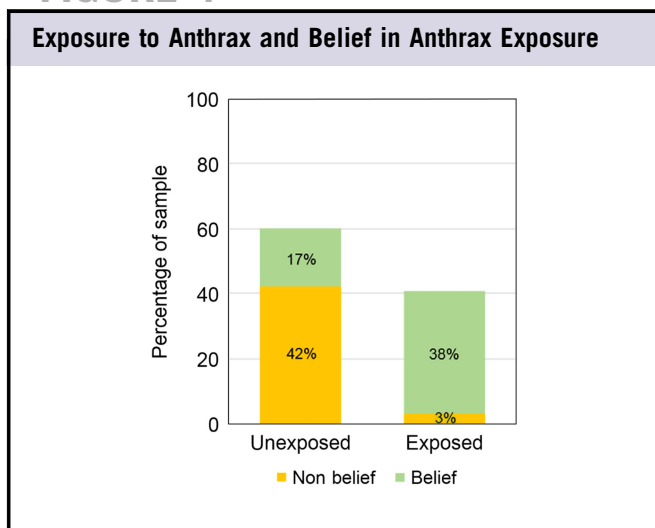


TABLE 1

Multivariate Model Comparing Number of Symptoms by Symptom Group (Dependent Variable, 1 per Row) With Belief in Anthrax Exposure (Independent Variable) Among Unexposed Participants

Symptom Group	Sex	Antibiotics	Postdisaster Major Depression	Disaster-Related PTSD	Belief Among Those Who Were Unexposed
					<i>P value</i>
Constitutional	.001	NS	NS	NS	NS
ENT	NS	NS	NS	NS	.018
CV	.007	NS	NS	NS	NS
GI	NS	NS	NS	NS	NS
MSK	NS	NS	NS	NS	.032
Skin	.025	NS	.006	NS	NS
Neurologic	NS	NS	NS	NS	NS
Psychological	NS	.009	NS	NS	NS
Pain ^a	.044	NS	NS	NS	NS
Physical ^b	.003	NS	NS	NS	.018
All symptoms	.003	NS	NS	NS	NS

Abbreviations: CV, cardiovascular; ENT, eyes/nose/throat; GI, gastrointestinal/genitourinary; MSK, musculoskeletal; NS, not significant; PTSD, posttraumatic stress disorder.

^aPain group includes pain-related symptoms from the physical symptom groups.

^bPhysical group represents the sum of all symptom groups excluding the psychological group.

unexposed were associated with the total number of symptoms endorsed (see Tables 1 and 2). Both postdisaster major depression and disaster-related PTSD were positively associated with the number of psychological symptoms among those exposed.

DISCUSSION

Despite the fact that none of the individuals in the study were infected with anthrax, incident postdisaster symptoms were abundant, reported by nearly two-thirds of the participants. Based on these proportions, the study suggests that bioterrorist incidents in the future could be associated with overwhelming postdisaster symptoms even if the disaster does not result in direct physical harm and all victims receive prophylactic treatment. Given the high incidence of these postdisaster symptoms, these data suggest that even in the absence of physical injury or illness, there are likely to be surges in health care utilization, medical cost burdens, and morbidity arising from medical testing and treatment.

Belief in anthrax exposure, but not actual anthrax exposure, was associated with the number of postdisaster symptoms. Actual anthrax exposure was associated with postdisaster symptoms in bivariate analyses, but in multivariate models

TABLE 2

Multivariate Model Comparing Number of Symptoms by Symptom Group (Dependent Variable, 1 per Row) With Anthrax Exposure (Independent Variable) Among Those Believing They Were Exposed

Symptom Group	Sex	Antibiotics	Postdisaster Major Depression	Disaster-Related PTSD	Anthrax Exposure Among Those Who Believed They Were Exposed
					<i>P value</i>
Constitutional	NS	NS	NS	NS	NS
ENT	NS	NS	NS	NS	NS
CV	NS	NS	NS	NS	NS
GI	NS	NS	NS	NS	NS
MSK	NS	NS	NS	NS	NS
Skin	.005	NS	NS	NS	NS
Neurologic	NS	NS	NS	NS	NS
Psychological	NS	NS	<.001	.008	NS
Pain ^a	NS	NS	NS	NS	NS
Physical ^b	.049	NS	NS	NS	NS
All symptoms	.047	NS	NS	NS	NS

Abbreviations: CV, cardiovascular; ENT, eyes/nose/throat; GI, gastrointestinal/genitourinary; MSK, musculoskeletal; NS, not significant; PTSD, posttraumatic stress disorder.

^aPain group includes pain-related symptoms from the physical symptom groups.

^bPhysical group represents the sum of all symptom groups excluding the psychological group.

this association was not present; rather, it was belief in exposure that was associated with postdisaster symptoms. These symptoms may not represent a psychopathological process; otherwise, one would expect them to be associated with disaster-related psychiatric disorders, but they were not. Further, belief in anthrax exposure was not associated with psychological symptoms. These findings suggest that physical symptoms, at least those endorsed in a research interview, may largely represent normative responses to a bioterrorist event rather than manifestations of psychiatric illness.

People with medically unexplained symptoms have been observed to report symptoms in patterns that seem logical to their concept of illness.²⁰ In the case of anthrax, the association of ENT symptoms with belief in exposure may be related to the participants' understanding of inhalation anthrax, the deadliest form of anthrax. Similarly, the association of MSK symptoms with belief in exposure may be related to individuals' knowledge that MSK symptoms are part of the prodromal phase of anthrax infection. The association of belief with physical rather than psychological symptoms may also relate to participants' understanding of anthrax as a purely physical illness.

Belief in exposure may represent 1 component of risk perception, a related concept. Risk perception is thought to be shaped by the particular characteristics of the hazard, and comprehensive lists of the characteristics that intensify risk perception have been compiled by risk perception experts.^{1,21} The Capitol Hill anthrax incident had several of the characteristics associated with high risk perception, including uncertainty of exposure, the man-made origin of the hazard, the risk of contracting a dreaded condition, localization of the threat to a geographic area, and disagreement among experts about the hazard. An end product of risk perception is the individual's response to the hazardous situation. In this study, the specific individual response that was examined was symptom-endorsing behavior. The association of belief in exposure with symptoms in this study is consistent with the possibility that the belief component of risk perception may be driving the symptom-endorsing response to anthrax.²²

Strengths of the study include the collection of data on both actual anthrax exposure and participant beliefs regarding their exposure status, which allowed for the consideration of both factors in evaluating symptoms post anthrax. Data were collected on incident symptoms after the anthrax attacks rather than lifetime symptoms, suggesting a causal relationship to the anthrax attacks. Structured diagnostic interviews assessing full diagnostic criteria were used for postdisaster PTSD and major depression assessment. The 7-month duration between anthrax exposure and collection of the data allowed for the completion of participants' medical assessment including the determination that none had been infected. The multivariate models controlled for both antibiotic side effects and psychiatric disorders in predicting symptoms reported after the anthrax attacks.

The study also had some methodological limitations. The volunteer sample in the study is not necessarily representative of all congressional staff; however, it did include more than half of the staff in the most-exposed offices. The length of time elapsed between the anthrax exposure and interviews for this study was long enough to introduce potential for memory distortion. No statistical corrections were provided for multiple comparisons because of the exploratory nature of the study. As the interview did not limit the inquiry to medically unexplained symptoms, some of the reported symptoms may be medically explained, such as through unrelated medical conditions or side effects from antibiotics, which were widely prescribed for prophylaxis.^{3,23} However, the analyses controlled for symptoms medically explained by antibiotic side effects. Attempts at analysis of symptoms attributed specifically to anthrax separately from other new or worsened symptoms were not productive, perhaps reflecting participants' inability to make such distinctions. The symptoms elicited on a research interview may represent largely normative or nonpathological responses to the incident and may not necessarily be representative of the types of physical symptoms that prompt individuals to present for clinical care.

The worried well population is likely a heterogeneous group,³ and to the degree that belief in exposure might represent a mechanism for development of medically unexplained symptoms for certain subgroups, it could then serve as an important modifiable risk factor. A tool to modify belief in exposure may be risk communication, which is an exchange designed to make communication effective in high-risk and emotional situations.²¹ There are 3 major objectives with risk communication: provide the knowledge needed for the public to make informed decisions, build trust among stakeholders, and foster dialogue to resolve conflicts and reach consensus. The objective of risk communication that is particularly relevant to the findings of this study is providing knowledge about the hazards and exposures. To make informed health decisions, such as the decision of whether to seek health care after a bioterrorist incident, individuals need good information about their exposure status, especially in situations that may entail high levels of uncertainty. Helping unexposed individuals understand their exposure status may be 1 tool to address the high numbers of medically unexplained symptoms.

CONCLUSIONS

This study found a high incidence of medically unexplained symptoms following a bioterrorist attack. It is possible that these symptoms can cause surges in health care utilization; therefore, further investigation into the prevention of these symptoms is needed. The finding of an association between belief in exposure and postdisaster medically unexplained symptoms suggests potential interventions to be developed and tested. Studies are needed to test the effects of risk communication interventions to reduce the likelihood that unexposed people will develop belief in exposure, to reverse belief in exposure among the unexposed, and to decrease the incidence of medically unexplained symptoms after a disaster.

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Conflicts of Interest

The authors declare no conflicts of interest

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