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Post-Traumatic Stress Disorder among World War II Mustard Gas Test Participants

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Open-ended and structured interviews were conducted to assess post-traumatic stress disorder (PTSD) and other psychosocial outcomes among 24 men who had participated in the military's mustard gas testing program during World War II. Most men had volunteered (92%) and had participated in chamber tests (96%). During the tests, few (22%) understood the danger involved. The majority (67%) were ordered to refrain from discussing their participation with anyone. Most men (83%) experienced physical symptoms subsequent to the test. At present, the men were less psychologically and physically healthy than expected for men of similar age. The current prevalence of PTSD due to the mustard gas was 17%. The current prevalence of subdiagnostic mustard-gas-related PTSD was 25%. Lifetime estimates for full and subdiagnostic PTSD were 17 and 33%, respectively. The only mustard gas experience that predicted lifetime full or subdiagnostic PTSD was the number of exposures to the gas.

Introduction

Mustard gas and Lewisite are chemicals that have been used as weapons in several military conflicts in this century, most notably in World War I, and more recently, in the Iran-Iraq War. A report by the National Academy of Sciences (NAS) provides an excellent summary of knowledge about these chemicals.[1] Briefly, they cause blisters and other tissue damage, especially to the eyes and respiratory tract. Both mustard gas and Lewisite can be fatal, and mustard gas is a known carcinogen.

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According to the NAS report,[1] during World War II (WWII) the United States military conducted secret tests of the effectiveness of various strategies for protecting combatants against the effects of mustard gas and Lewisite (which we will refer to collectively as "mustard gas" below). At least 4,000 men were extensively exposed to these agents while participating in tests of protective clothing, either by being placed in a sealed room into which a chemical was introduced (a "chamber" test) or by traversing a contaminated area (a "field" test).

The NAS report[1] describes the chamber tests: "These tests were called "man-break" tests. The common procedure was to equip men with gas masks and clothe them in impregnated suits. The men would enter the gas chamber and remain there for periods from 60 minutes to 4 hours. . . Twenty-four hours after each chamber trial the men were examined for reddening of the skin (erythema), evidence that the vapor had penetrated the suits and burned the skin. The men were required to repeat the procedure and enter the chambers either every day or every other day until they developed moderate to intense erythema" (pp 36–9).

In the field tests, participants spent 1 to 72 hours traversing an area that had been bombed with mustard gas. They were required to drop to the ground periodically so that they would have direct contact with contaminated surfaces; the densest concentration of mustard gas would be at ground level because it is heavier than air. Participants in both types of tests sometimes had insufficient protection, due to the intention of the experimenters (to evaluate a particular item or strategy), faulty equipment, or improper use of equipment.

Until recently, the experiences of individuals who participated in these experiments were not known because they had been sworn to secrecy and most had kept their oath.[1] Some even had been threatened with incarceration if they broke their silence. When the story finally broke several years ago, it became apparent that many men had suffered significant medical and psychological problems as a result of their participation in the tests and that their rights as human subjects

had not been protected. Typically, participants had volunteered without knowing the precise nature or potential danger involved in the tests. They also were given incomplete information about frightening events they may have witnessed in the chambers, such as other men losing consciousness and being removed.[1]

The NAS report[1] also dealt with the problems many men have had in trying to get help from the Department of Veterans Affairs (VA) for treatment of and compensation for problems that they have had since their participation in the mustard gas testing program. The poor and secretive nature of record-keeping for the experiments made it essentially impossible for VA staff to document a man's participation, and the secrecy surrounding the program made such claims seem implausible in any case. In 1992, however, the VA began to allow compensation for seven medical conditions that may have resulted from mustard gas exposure. Following publication of the NAS report, the VA extended the list to include additional medical conditions. Psychiatric disorders were not included on the list, despite the panel's conclusion that post-traumatic stress disorder (PTSD) and other traumatic stress responses could have resulted from participating in either the chamber or field tests.

PTSD is an anxiety disorder that occurs among survivors of traumatic events.[2] Although typically associated with events such as military combat, natural disasters, and personal or sexual violence, PTSD also may occur following accidental exposure to toxic substances or technological disasters.[3-6] It is characterized by three symptom clusters: re-experiencing the traumatic event, avoidance of stimuli associated with the event or feeling numb, and increased arousal. PTSD has emerged as an important public health concern as studies continue to document both the frequency of serious trauma in the population and the numerous problems associated with PTSD.[7,8] These problems include not only PTSD symptoms themselves, but also other co-morbid psychiatric disorders (such as major depressive disorder and substance abuse), psychosocial impairment, increased mental and physical health service utilization, and perhaps actual physical health problems resulting from the hyperreactivity and hyperarousal that characterize the disorder.

Given that even routine chemical warfare training can provoke extreme psychological reactions in some individuals,[9] it is possible that the mustard gas experiments, with the fear that they engendered in many participants, could have precipitated PTSD. Thus, our primary objective was to assess PTSD among participants in the mustard gas testing program. A secondary objective was to assess other psychological, psychosocial, and physical health outcomes. We also tested aspects of mustard gas test participation and other traumatic experiences as predictors of lifetime PTSD.

Method

Subjects

Names and addresses of potential subjects were obtained from a registry being developed for a mortality study of mustard gas test participants that was being conducted by VA's Office of Public Health and Environmental Hazards. Lists were requested for several locations chosen for their proximity to study investigators or the density of participants in a region. Additional names and addresses were obtained from participants themselves, who shared with the study team their knowledge of informal networks that existed among the men.

We attempted to contact 36 men. Of the 31 who were still alive, 24 participated (77%). Reasons for non-participation were as follows: refusal (n = 1), scheduling problems (n = 4), and psychiatric impairment (n = 2).

The average age of the 24 men in our sample was 68.6 years (SD = 3.0). Most men were white (95.7%) and married (87.5%). The majority (79.2%) had at least a high school diploma, and 50% were or had been employed in a white-collar occupation. Most (79.2%) were retired, and the modal annual income range was $20,000 to $29,000.

Instruments

We used the Structured Clinical Interview for DSM-III-R (SCID)[10] to assess DSM-III-R[11] diagnoses of current and lifetime PTSD due to mustard gas and current and lifetime PTSD due to other traumatic events. PTSD diagnoses were scored as fully present, subthreshold, or absent. Using criteria developed by Schnurr et al.,[12] we made a subthreshold diagnosis if an individual met the traumatic event (A) and duration (E) criteria necessary for a full diagnosis, while also: meeting B (re-experiencing) and D (hyperarousal), but not C (numbing-avoidance) symptom criteria; meeting B and having at least one C and one D symptom; or having the sufficient number of B, C, and D symptoms but with some or all rated as subthreshold. We also used the SCID to assess overall psychosocial functioning (with the Global Assessment Scale, or GAS), current and lifetime prevalence of major depressive disorder, alcoholism, and generalized anxiety disorder (which is coded as current only).[10,11]

We assessed the number of lifetime stressful and traumatic events (other than participation in the mustard gas tests) that each man had experienced by using a Stressful Events Screening Questionnaire, which asked about the occurrence of eight types of events (Green BL, Krupnick J, Corcoran C, et al: Trauma types and dimensions: specificity of outcomes. Ongoing National Institute of Mental Health-funded study R01 MH50332, 1994). Combat exposure, coded "yes/no," was assessed from the open-ended portion of our interview.

We also assessed PTSD symptoms with the Impact of Event Scale (IES),[13] which has subscales for intrusion and avoidance, as well as an overall symptom measure (scored as recommended by Zilberg et al.[14]). General psychiatric symptoms were measured by the Brief Symptom Inventory (BSI),[15] which has an overall score reflecting general psychiatric distress as well as subscales for specific symptom clusters such as anxiety and depression. Measures of perceived and functional health status were obtained from the instrument developed as part of the Medical Outcomes Study, the SF-36.[16]

Procedure

Subjects were screened by telephone by a psychiatrist (M.J.F.) and were invited to participate if he thought they could tolerate an extensive psychiatric interview. Interviews were conducted by either a psychiatrist, a licensed doctoral-level psychologist, or a master's-level social worker. All had previous

experience administering the SCID. Most interviews were conducted in subjects' homes, although a few took place in an interviewer's office. The interviews lasted approximately 3 hours; the range was 2 to 6 hours.

All assessment instruments, even questionnaires, were administered orally. For questionnaires with structured response alternatives, a response option card was given to the subject in order to facilitate his responding. The interviewer began by obtaining informed consent and then initiated open-ended interviewing about childhood and pre-military factors. Next, the interviewer inquired about military service, mustard gas test participation, and other significant traumatic military experiences such as combat. Finally, the interviewer administered the structured interviews and questionnaires.

A research assistant coded audiotapes of the interviews to obtain information about mustard gas test participation and the attributions that individuals had made about it.

Results

Table I contains information about subjects' experiences in the mustard gas test program. Most men were volunteers who had participated in a chamber experiment. The two men who did not volunteer participated in field tests; one of these reported participating in a chamber test prior to being ordered into the field. On average, men had just under six exposures to the gas. At recruitment most were not given information that would have been sufficient for making an informed decision about whether to participate. An oath of silence was demanded from two-thirds. Two-thirds (although not necessarily the same men who had been asked to keep an oath of silence) had not told anyone about their participation until the story broke in the 1990s. Over 80% experienced physical problems at the time of the test, primarily of a dermatological nature. Table I also shows that almost two-thirds of the men were combat veterans, and had experienced an average of slightly more than two significantly stressful events during their lives.

Table II contains information about PTSD and other selected psychiatric diagnoses in the study sample. Regarding our objective of assessing for the diagnosis of PTSD, we found that 50% had a full or subthreshold lifetime PTSD diagnosis due to participation in the mustard gas test program, and over 40% currently had full or subthreshold mustard-gas-related PTSD. We also observed PTSD due to other events, but it was relatively infrequent and was observed only in men who had no lifetime or current PTSD or subthreshold PTSD due to mustard gas. Alcohol abuse or dependence also was infrequent. Major depressive disorder was the most common full diagnosis, both current and lifetime.

Table III contains information about psychological and physical health outcomes in the study sample. Based on normative data from a variety of samples, or information from a test's developers, it is possible to describe the functioning of our sample. The group's overall mean on the GAS indicates that they were rated by the interviewers as having generally good functioning. Ratings between 70 and 80 indicate only slight impairment in social or occupational functioning and mild reactivity to stressors.[10] Their PTSD symptom scores on the IES and its subscales were similar to the scores of individuals in the community who discovered that they were living next to a toxic landfill, and slightly higher than those for survivors of the nuclear accident at Three Mile Island, with both groups having elevated scores relative to individuals in a control community.[3]

On the BSI, the group as a whole was only slightly more impaired than the average nonpatient male; their scores on the Global Severity Index and on most subscales fell at the 60th percentile.[15] The exception to this trend was for the somatization scale, on which the group as a whole was at the 70th percentile for nonpatient males. The SF-36 is scored on a scale

TABLE I

MUSTARD GAS TEST EXPERIENCES AND EXPOSURE TO OTHER SIGNIFICANT STRESSORS

	Mean or Percent	SD or Frequency	*N*
Participated in chamber experiment (% yes)	95.8	23	24
Participated in field experiment (% yes)	8.7	2	24
Volunteered (% yes)	91.7	22	24
Number of separate exposures to gas	5.56	5.54	24
At recruitment			
Knew test was an experiment (% yes)	29.2	7	24
Knew test involved mustard gas (% yes)	37.5	9	24
Knew test was dangerous (% yes)	21.7	5	23
Oath of silence demanded (% yes)	66.7	14	21
Did not disclose until 1990s (% yes)	66.7	12	18
Any physical problem at time of test (% yes)	82.6	19	24
Ophthalmological (% yes)	4.3	1	23
Dermatological (% yes)	78.3	18	23
Respiratory (% yes)	26.0	6	23
Other (% yes)	18.2	4	22
Experienced combat in military service (%)	61.9	13	21
Number of lifetime stressful events	2.27	1.20	22

TABLE II

SELECTED PSYCHIATRIC DIAGNOSES IN MUSTARD GAS TEST PARTICIPANTS (N = 24)

	Present	Subthreshold	Absent
PTSD due to mustard gas			
Lifetime	16.7 (4)	33.3 (8)	50.0 (12)
Current	16.7 (4)	25.0 (6)	58.3 (14)
PTSD due to other event			
Lifetime	8.3 (2)	4.2 (1)	87.5 (21)
Current	8.3 (2)	4.2 (1)	87.5 (21)
Major depressive disorder			
Lifetime	33.3 (8)	4.2 (1)	62.5 (15)
Current	29.2 (7)	0.0 (0)	70.8 (17)
Alcohol abuse/dependence			
Lifetime	12.5 (3)	4.2 (1)	83.3 (20)
Current	4.2 (1)	0.0 (0)	95.8 (23)
Generalized anxiety disorder			
Current	12.5 (3)	8.3 (2)	79.2 (19)

Frequencies for percentages appear in parentheses.

from 0 to 100, with 0 indicating the most negative outcome for each subscale. It has age and gender norms.[17] Compared with 65- to 69-year-old nonpatient males, our sample reported poorer health and functioning on all of the scales except for "health compared to one year ago." We observed differences greater than 20 points on subscales for general health perception, limits in role functioning due to physical problems (which is reverse-scored so that low values indicate greater limits), energy/fatigue, and pain; normative values are 66, 73, 63, and 72, respectively.

Given the unique nature of the traumatic stressor to which our sample was exposed, we examined how the development of PTSD was related to the mustard gas test experiences (e.g., having volunteered) and trauma exposure variables (e.g., combat exposure) presented in Table I (excluding items about the nature of specific physical problems). We combined the 12 men who had either a full or subthreshold lifetime diagnosis of mustard-gas-related PTSD and compared them with the 12 men who did not have a lifetime diagnosis of mustard-gas-related PTSD. We performed t tests for continuous variables and Fisher's exact tests for dichotomous variables, using a two-tailed p value of 0.05 for statistical significance. Only 1 of the 12 tests showed a statistically significant difference between groups. The PTSD group had more exposures than the no PTSD group to mustard

TABLE III

PSYCHOLOGICAL AND PHYSICAL HEALTH MEASURES IN MUSTARD GAS TEST PARTICIPANTS

	Mean	SD	N
SCID Global Assessment Scale	72.6	11.6	22
Impact of Event Scale: total	25.3	19.2	23
Intrusion	14.8	11.7	23
Avoidance	10.6	9.3	23
Brief Symptom Inventory: global severity	0.50	0.62	23
Anxiety	0.63	0.83	23
Depression	0.45	0.64	23
Hostility	0.63	0.78	23
Interpersonal sensitivity	0.54	0.94	23
Obsessive-compulsiveness	0.97	1.04	23
Paranoid ideation	0.89	1.03	23
Phobic anxiety	0.43	0.73	23
Psychoticism	0.32	0.41	23
Somatization	1.14	0.97	23
SF-36 measures			
General health perception	38.5	27.6	24
Health compared to 1 year ago	49.0	23.9	24
Physical function	51.7	29.0	23
Social function	70.1	29.3	23
Role dysfunction due to physical problems	40.2	43.1	23
Role dysfunction due to emotional problems	69.6	42.5	23
Mental health	70.6	24.1	23
Energy/fatigue	46.1	24.4	23
Pain	38.5	27.6	24

gas (t [13.8] = 2.33, p = 0.04, with correction for unequal variances). The PTSD group had been exposed an average of 7.8 times (SD = 6.60), whereas the no PTSD group had been exposed an average of 3.1 times (SD = 2.18).

Discussion

Overall, our sample of men who participated in WWII mustard gas test experiments had poor mental, physical, and functional health, relative to norms. We observed PTSD related to the mustard gas tests and were able to distinguish this condition from PTSD due to other traumatic events. In addition, we found that some men had notable PTSD symptoms but did not meet full criteria.

The finding of subdiagnostic PTSD is consistent with findings of the National Vietnam Veterans Readjustment Study[18] and studies of other cohorts.[7,8] Direct comparisons with other cohorts are difficult, however. Mustard gas test participants could be expected to be similar to WWII prisoners of war and Holocaust survivors in both the duration of time since their initial trauma and the likelihood of accompanying serious physical injury or illness. And although the gas survivors were not exposed to the deaths of others or the extent of immediate threat to life that was experienced by prisoners of war and Holocaust survivors, they have lived with the complication of nearly a lifetime of secrecy. The secrecy and the long latency until revelation of the trauma to others may make mustard gas test participants more similar to survivors of childhood sexual and physical abuse and to adult rape victims, many of whom fear the stigma of disclosure or are threatened by perpetrators into remaining silent. This secrecy likely contributed an important dynamic to the experience, since not telling others about a traumatic event that one has experienced is related to increases in negative psychological[19] and physical[20] health outcomes.

Given the importance that has been ascribed to both immediate intervention and social support in mediating the outcome of traumatic exposure,[21,22] we might have expected that PTSD would be associated with increased likelihood of not having told anyone about participation in the mustard gas tests. Yet this was not the case. Both PTSD and no PTSD groups were equally likely to have told others about their participation in the tests. The lack of difference between groups may be due to the fact that we did not systematically assess disclosure, i.e., we asked about it using open-ended questions only and not all participants gave codable answers.

The only mustard gas test experience associated with PTSD was number of exposures. Men with full or subthreshold PTSD had many more exposures than did men without PTSD. A dose-response relationship between exposure and PTSD is a common finding in studies of traumatized populations.[7,8,18]

The failure to find differences between the PTSD and no PTSD groups on secrecy is unlikely to be due to our small sample size because the groups were so highly similar on these variables. However, our sample size prevented us from finding statistical significance for all but the largest differences between the PTSD and no PTSD groups. Thus, our failure to find other mustard gas test characteristics related to the development of full or subthreshold PTSD may be primarily a statistical problem that would be remedied by a larger sample size.

Anecdotally, we note that several men reported a worsening of their psychological symptoms after viewing a *60 Minutes* television broadcast several years ago and learning the extent to which they had been deceived about the potential danger of the tests. This is not surprising, as information about a traumatic experience that is acquired after the experience can alter a victim's reactions.[23] The retrospectively increased fear of the mustard gas is similar to the reactions of individuals who have been exposed to "invisible" contaminants. Exposure to such hazards as toxic waste or radiation may occur for many years before individuals learn that they have been exposed. An exposed individual may not even perceive an event as traumatic at the time and only react negatively after learning about the potential injury or disease that might result from exposure.[24] The elevated somatization scores in our sample are consistent with the profile of contaminated populations.[25]

When interpreting our results, it is important to consider that we used a sample of convenience, composed mostly of men who had contacted the NAS or VA because of problems they perceived to be related to their participation in the mustard gas tests. It may be more difficult to locate a random sample of men, and such men may be less willing to talk about their experiences than those who have sought help for mustard-gas-related problems. However, not all of the men we interviewed had sought help, and a number reported a general absence of psychosocial or physical problems due to the tests. We thus feel that our sample represented a reasonable range of the types of outcomes that surviving participants have had over the years.

One consequence of using a convenience sample is that we cannot generalize our findings on the prevalence of psychiatric disorder and the extent of other problems to the population of surviving participants. The actual prevalence of PTSD and other disorders and the level of problems may be higher or lower than what we observed. Nevertheless, we are confident in saying that some men have PTSD due to their participation in the WWII mustard gas tests. We encourage recognition of the problem among the older veteran population.

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