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Injuries and Illnesses Among New York City Fire Department Rescue Workers After Responding to the World Trade Center Attacks

Within minutes of the terrorist attacks on September 11, 2001, the Fire Department of New York City (FDNY) operated a continuous rescue/recovery effort at the World Trade Center (WTC) site. Medical officers of FDNY Bureau of Health Services (FDNY-BHS) responded to provide emergency medical services (see box). The collapse of the WTC towers and several adjacent structures resulted in a vast, physically dangerous disaster zone. The height of the WTC towers produced extraordinary forces during their collapse, pulverizing considerable portions of the buildings' structural components and exposing first responders and civilians to substantial amounts of airborne particulate matter. Fires burned continuously under the debris until mid-December 2001. Because of ongoing fire activity and the large numbers of civilians and rescue workers who were killed during the attacks, approximately 11,000 FDNY firefighters and many emergency medical service (EMS) personnel worked on or directly adjacent to the rubble and incurred substantial exposures (Figure). This report describes morbidity and mortality in FDNY rescue workers during the 11-month period after the WTC attacks and documents a substantial increase in respiratory and stress-related illness compared with the time period before the WTC attacks. These findings demonstrate the need to provide acute and long-term medical monitoring, treatment, and counseling to FDNY rescue workers exposed to this disaster and to solve supply, compliance, and supervision problems so that respiratory protection can be rapidly provided at future disasters.

During the collapse, 343 FDNY rescue workers died and, during the next 24 hours, an additional 240 FDNY rescue workers sought emergency medical treatment. This report includes all reported injuries/illnesses during the 24 hours following the attacks. Traumatic injuries are reported for the

FIGURE. New York City Fire Department rescue workers at the World Trade Center site

AP (Associated Press) photo/Mark Lennihan

INSIDE

Use of Respiratory Protection Among Responders at the World Trade Center Site — New York City, September 2001

The terrorist attacks on the World Trade Center (WTC) on September 11, 2001, created an occupational health and safety challenge for New York City (NYC) firefighters and rescue workers responding to the disaster. Immediate respiratory hazards included explosions, fire, falling debris, and dust clouds containing particulate matter comprised of pulverized building materials. Ongoing risks included lingering particulate matter in the air and intermittent combustion products from initial and persistent fires beneath the rubble pile. Because the nature and extent of exposures in disaster situations are complex and difficult to characterize, the use of adequate personal protective equipment (PPE), including respiratory protection, is essential in protecting the health of firefighters and other rescue workers. During the weeks after September 11, the NYC Fire Department's Bureau of Health Services (FDNY-BHS) and CDC's National Institute for Occupational Safety and Health (NIOSH) organized a collaborative study to evaluate occupational hazards and exposures for these workers, including their use of respiratory protection. This report summarizes the results of that study, which indicate that the majority of firefighters did not use adequate respiratory protection during the first week of the rescue/recovery operation.

The study population consisted of the approximately 11,000 FDNY firefighters present at the WTC site during the first week of the disaster. The cross-sectional study used a stratified random sample of firefighters, categorized by arrival time at the WTC. The study was conducted during October 2–5 and included a questionnaire (self-administered through touch-screen computer), medical evaluation, spirometry, and blood/urine collection for biomonitoring assays. The 53 questions elicited arrival time, number of days worked at the WTC, work activities, and use of PPE (including respiratory protection) during each day worked at the WTC during the first 2 weeks. The medical evaluation was mandatory, but participation in the research study was voluntary and required informed consent.

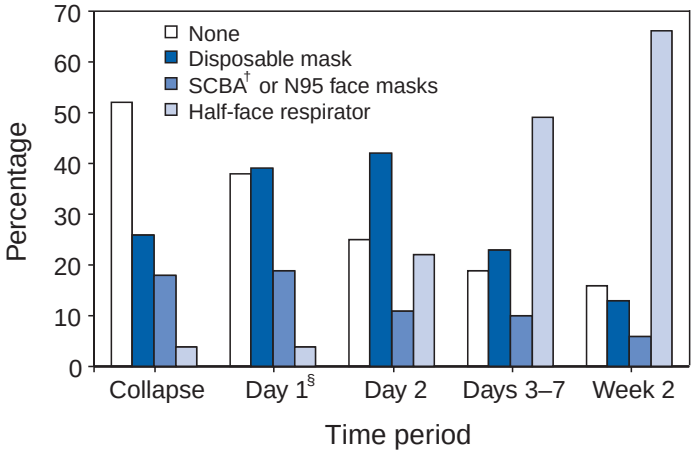
The respiratory protection section of the questionnaire elicited firefighter respirator use during each of the five time periods: during the collapse, day 1, day 2, days 3–7, and week 2 following the collapse. The number of participants present each day was calculated and used to generate rates of respirator use for each time period by respirator type. Questionnaire choices included the following four types of respirators used by firefighters, regardless of availability: 1) self-contained breathing apparatuses (used for firefighting), 2) N95 filtering face masks (used for medical response), 3) half-face respirators,* and 4) disposable dust/paint masks (hardware store type). The disposable dust/paint mask might not have been a NIOSH-certified respirator.

Of 400 firefighters, 361 (91%) participated in the study; 319 had responded to the WTC disaster, and 42 were unexposed controls. All participants were men; mean years worked as a firefighter was 15 years (range: <1–38 years), and mean age was 42 years (range: 24–60 years). The firefighters who responded to the disaster were asked whether they were present at the site during various time periods: 149 reported being present during the collapse, 118 arrived later that day, 222 were present on day 2, a total of 284 were present ≥1 day during days 3–7, and 231 were present during week 2.

Of those present during the WTC collapse, 67 (52%) reported wearing no respiratory protection, and 41 (38%) of those arriving later that day wore no respirator (Figure). The respirator most commonly used during the first day was the disposable mask; of the 130 firefighters present on the first day (either during or following the collapse) who reported wearing a respirator, 76 (58%) used the disposable mask. During the initial 2-week period, use of half-face respirators increased, and use of the disposable masks decreased.

*The half-face elastomeric reusable respirator with combination P100 and organic vapor/acid gas cartridges were recommended by NIOSH and other agencies for WTC rescue/recovery personnel working in debris or performing decontamination at the WTC site (work in which surface dust was disturbed or resuspended in the air). For workers not scheduled to work in debris, a half-face P100 or N100 respirator (either disposable or elastomeric) was recommended; however, these were not available routinely during the initial 48 hours.

FIGURE. Percentage of firefighters who used respiratory protection during and following the World Trade Center attacks, by time period and type of respirator — New York City, September 2001*



*n=319.
†Self-contained breathing apparatus.
§Includes firefighters who arrived on day 1 but following the collapse.

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Editorial Note: Adequate planning, preparation, and training are key to protecting the safety and health of emergency responders. Anticipating the nature and magnitude of exposures during the initial stages of a disaster situation is difficult; however, plans should be in place to provide a rapid emergency response and protect the health of the responders. The findings in this report indicate that many firefighters responding to the WTC disaster were not protected adequately during the initial stages of the emergency response.

The findings in this report are subject to at least two limitations. First, the collection of reliable information about respirator use patterns is difficult. Some firefighters reporting use of a respirator might not have been fit-tested adequately or might have used it sporadically, resulting in an overestimation of the percentage of those who were protected adequately. Second, because firefighters were asked to report daily respirator use 3–4 weeks after the event, responses are subject to recall bias. Despite these limitations, the general results from the questionnaire are consistent with reports by safety experts who were present during the first few weeks of the rescue/recovery operations.

To evaluate the availability and adequacy of PPE during disaster situations and to make recommendations for future planning, CDC, in collaboration with the RAND Science and Technology Policy Institute, sponsored a conference of persons with first-hand knowledge of emergency response to terrorist attacks. The conference was held in NYC in December 2001. Attendees included persons who responded to the 1995 attack on the Alfred P. Murrah Federal Building in Oklahoma City, the September 11 attacks on the WTC and the Pentagon, and the anthrax incidents that occurred during fall 2001, and represented multiple occupations and skills (e.g., firefighters, police, emergency medical technicians, construction workers, union officials, and government representatives from local, state, and federal agencies).

The participants discussed all aspects of a program for protection of emergency responders including information and training, performance of particular PPE in a disaster environment, and concerns related to adequate management of disaster sites. On the basis of this experience, participants developed recommendations about technologies and procedures that could help protect the health and safety of emergency workers as they respond to acts of terrorism. The final recommendations included the following (*1*):

PPE Performance

- Develop guidelines for appropriate PPE ensembles for long-duration disaster responses involving rubble, human remains, and different respiratory threats. If appropriate equipment is not available, address barriers to its development. Such equipment could be applicable to other major disasters (e.g., earthquakes or tornadoes) and to terrorist attacks.
- Define the appropriate ensembles of PPE needed to respond safely and efficiently to biologic incidents, threats, and false alarms. Key considerations include providing comparable levels of protection for all responders and addressing the logistical and decontamination concerns associated with large numbers of responses in short time periods.

PPE Availability

- Explore effective ways to outfit all responders at large incident sites with appropriate PPE as rapidly as possible.
- Examine barriers to equipment standardization or interoperability among emergency-responder organizations. Strategies could include coordinating equipment procurement among organizations or working with equipment manufacturers to promote broader interoperability within classes of equipment.

Training and Information

- Define mechanisms to provide responders at incident sites rapidly and effectively with useful information about potential hazards and the equipment they need for protection. Approaches could include more effective coordination among relevant organizations and development of technologies that provide responders with individual, real-time information about their environment.
- Ensure that responders at large-scale disaster sites are trained appropriately to use PPE. All responders must be trained, and mechanisms that provide training and experience with the equipment before a disaster occurs should be investigated.
- Consider logistical requirements of extended-response activities during disaster drills and training. Such activities provide response commanders with information on logistical constraints to response capabilities.

Management

- Provide guidelines and define organizational responsibilities for enforcing PPE use at major disaster sites. Although such guidelines must address the risks responders are willing to take when the potential exists to save lives, they also should reflect the principle that the health and safety of responders should be a primary concern during long-term responses.
- Develop mechanisms to allow rapid and efficient scene control at disaster sites as early as possible during a response.

Acknowledgment

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Reference

1. RAND Science and Policy Institute. Protecting emergency responders: lessons learned from terrorist attacks. Santa Monica, California: RAND Science and Policy Institute, 2002. Available at http://www.rand.org/publications/CF/CF176.

Impact of September 11 Attacks on Workers in the Vicinity of the World Trade Center — New York City

In January 2002, CDC's National Institute for Occupational Safety and Health received requests for Health Hazard Evaluations from labor unions representing workers employed in buildings in the vicinity of the World Trade Center (WTC). Workers reported persistent physical and mental health symptoms that they associated with exposures from the WTC collapse and ensuing fires. To address these concerns, CDC conducted surveys of workers at four workplaces in New York City (NYC), a high school (high school A) and college (college A) near the WTC site, and a high school (comparison high school B) and college (comparison college B) ≥5 miles from the WTC site to determine rates of physical and mental health symptoms. This report summarizes the preliminary results of the employee surveys, which indicated that workers employed near the WTC site had significantly higher rates of physical and mental health symptoms than workers employed ≥5 miles from the site. Intervention programs should be tailored to address the needs of these workers, and the effectiveness of these programs should be evaluated. Further assessment is warranted to describe the nature and extent of illness in specific working groups and individual medical follow-up in those with persistent symptoms.

CDC conducted site visits and distributed self-administered questionnaires in January 2002 to staff at high school A (n=224) and comparison high school B (n=155), and in March 2002, to staff at college A (n=374) and comparison college B (n=204). Teaching, administrative, support, and noncontract staff were included in the survey. Respondents were asked about work duties, mental health and physical symptoms after September 11, past medical history, and activities related to events at the time of the WTC terrorist attacks.

Questions about physical symptoms were based on presumed types of exposures and employee concerns. Persons responding affirmatively to "Have you had any of the following symptoms after the WTC disaster on 9/11/01?" were defined as having symptoms. Physical symptoms included eye irritation, nose/throat irritation, cough, shortness of breath, chest tightness, wheezing, nausea, and indigestion. Persistent physical symptoms were defined as either 1) symptoms that existed before September 11 but worsened after September 11, or 2) new symptoms that developed after September 11 and had not improved.

To assess mental health symptoms, the Center for Epidemiologic Studies Depression Scale (*1*) was used to define symptoms consistent with major depression. The Veteran's Administration post-traumatic stress disorder (PTSD) checklist (*2*) was used to determine prevalence of PTSD.

Participation rates were 83% for high school A, 84% for high school B, 59% for college A, and 50% for college B. Staff at all four workplaces were similar by age, sex, race, education, and cigarette smoking status.

On September 11, approximately 40% of high school A and 31% of college A staff saw an airplane crash into the WTC; 50% and 44%, respectively, witnessed the WTC collapse. In all four workplaces, 30%–40% of the respondents knew someone who was injured seriously or killed during the disaster. College A reopened for staff on September 26, and high school A staff returned to their building on October 20. Both buildings were within two blocks of the still burning WTC site and adjacent to a barge operation carrying the debris to the landfill site outside Manhattan.

Approximately one fourth (27%) of staff at high school A and college A lost time from work because of physical symptoms experienced after the WTC disaster, compared with 14% at high school B ($p<0.003$) and 16% at college B ($p<0.004$). Compared with staff at high school B and college B, staff at high school A and college A reported a significantly higher prevalence ratio of new physician-diagnosed PTSD after September 11, but rates for allergies, asthma, and depression were not statistically different.