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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

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3 months after the attacks because many workers did not report their injuries initially so they could participate in the rescue effort. Respiratory and stress-related illnesses are reported for the 11 months after the attacks because onset might be delayed and/or influenced by repeated exposures. Stress-related illnesses include post-traumatic stress disorders, depression, anxiety disorders, and bereavement issues. Incidence rates after the attacks (September 11, 2001–August 22, 2002) are compared with rates for the preceding year (September 11, 2000–August 22, 2001). Cases were identified from the FDNY-BHS computerized medical data base, which includes data on all FDNY rescue workers who present to hospitals or treatment centers for emergency medical treatment or to FDNY–BHS for symptom/injury/illness evaluation, medical leave evaluations, the WTC exposure medical monitoring program, worker's compensation injury/illness claims, or disability/retirement evaluations. Typically, case ascertainment is complete because all FDNY rescue workers must report to FDNY–BHS for regular evaluations if they present to hospitals or treatment centers while on duty, require on- or off-duty medical leave, file worker's compensation, or request retirement disability.

The First 24 Hours Following the WTC Attacks

At the time of the attacks, 11,336 firefighters and 2,908 EMS workers were employed by FDNY. During the collapse, 343 FDNY rescue workers died (341 firefighters and two paramedics). During the first 24 hours, 240 FDNY rescue workers (158 firefighters and 82 EMS workers) sought emergency medical treatment (Table). Most (63%) were for eye irritation, respiratory tract irritation and exposure (any combination of mild exhaustion, dehydration, and eye and respiratory tract irritation) not requiring hospital admission. Of 28 FDNY rescue workers who required hospitalization, 24 had traumatic injuries including 17 with fractures, four with back trauma, two with knee meniscus tears, and one with facial burns (Table). One firefighter suffered a cervical spine fracture requiring surgery for stabilization and recovered without neurologic sequelae. Three FDNY rescue workers required hospital admission for life-threatening inhalation injuries. Eight FDNY rescue workers were evaluated for chest pain, and one EMS worker was admitted for suspected myocardial infarction; after evaluation, none was found to have coronary artery disease.

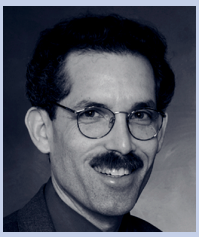
Recollections of 9/11 — Medical Officers of the New York City Fire Department

These personal recollections describe the conditions faced by persons responding to the World Trade Center attacks and the circumstances of the injuries and illnesses among New York City Fire Department (FDNY) rescue workers. These remarks were recorded in August 2002.

Drs. Kerry Kelly and David Prezant are the Chief and Deputy Chief Medical Officers, respectively, of FDNY. Approaching from different directions, they arrived on the scene shortly after the second plane hit the South Tower of the World Trade Center (WTC).


Kerry Kelly, M.D.

Dr. Kelly: As I made my way toward the nearest firehouse (Ladder 10/ Engine 10 on Liberty Street) in lower Manhattan, I saw people and debris raining from the towers. A group of FDNY firefighters called for me to help a firefighter who had just been hit by a civilian falling from the tower. The injury appeared fatal. We attempted to resuscitate him and then placed him in a nearby ambulance. A captain then escorted me across West Street towards the command center.


David Prezant, M.D.

Dr. Prezant: Every street had been closed off by police, only allowing entry to a steady stream of ambulances, fire trucks, and emergency vehicles. The chief-in-charge directed me to set up an EMS medical triage area directly in front of the South Tower. I was joined there by about 20 EMS workers.

Dr. Kelly: All of a sudden, the captain shouted, "Hurry up, the South Tower is falling!" We ran across the street, and he pushed me against a building, covering my body with his. The sound was deafening as debris pounded down. It was hard to breathe. The air was thick and choking. Then there was silence. It looked as though black snow had fallen, covering everything. Everyone was covered with gray powder; their features were indistinguishable.

Dr. Prezant: As the EMS workers and I began to set up a mini-triage area in the middle of West Street, there was a soft rumbling that sounded like a freight train. Everyone started to run across the street away from the tower. I had nearly reached the cover of a pedestrian bridge when I was blown off my feet and completely buried under debris. I knew I was going to die but it seemed to be taking forever. I pushed myself up to my knees and tried to maintain a position that could trap enough air to breathe. Several sheets of construction materials covered me and I was able to wedge myself out. I was surprised that I could stand up. It was as dark as a tunnel and the air was as thick as soup. Despite repeatedly scooping chunks of dust and debris from my mouth and nostrils, I inhaled and swallowed large quantities. I heard screams to my left and I began to walk toward them and met several firefighters. Together, we helped several civilians out of the debris. After walking one or two blocks, the sky lightened to a grayish color, and it became obvious that I had been trapped in a massive dust cloud. We were coughing continuously, and it was hard to see. I do not remember hearing the second tower collapse.

Dr. Kelly: Other FDNY rescue workers and I found two injured firefighters and brought them into a nearby parking garage. While we were looking for medical supplies, the second tower collapsed. A firefighter pushed me into a revolving door as the debris swooshed down the street. The gray turned to black once again. Afterwards we carried the two firefighters to an ambulance and later helped transfer them to a police transport boat. I walked south to the tip of Manhattan — the Battery.

Dr. Prezant: I saw Dr. Kelly for the first time. We grouped up with some other firefighters and headed back toward the collapse zone. We were then directed to a new staging area on Broadway and Vesey, several blocks from the collapse site. Together with physicians and nurses from FDNY, we opened a triage center in a pharmacy. Additional supplies came from local hospitals. Medical personnel responding to the WTC attacks were directed to this triage area.

Dr. Kelly: We started to hear rumors that WTC Tower 7 was going to collapse, and we all felt our triage area was too close for comfort and moved it across the street to Pace University. This location gave us greater space for anticipated trauma and eye/respiratory treatments. Unfortunately, the extra space was not needed, because many firefighters had died, and those left alive had been transported to hospitals or were hurriedly working at the site to rescue others. As the day wore on, most visits to the triage center were for eye/respiratory irritation requiring eyewashes and/or bronchodilators. The triage center was closed around 9:00 p.m. and we headed back to FDNY headquarters.

Dr. Prezant: We finally got back to headquarters. It took an hour to wash off the dust, which by now had become like a layer of concrete. I sat down to call my wife and tell her I was still alive. The phone line was difficult to hear through, and I thought she said that the TV showed pictures of both towers fully collapsed. I couldn't believe what she had said. Amazing — I had nearly been killed, and then worked there all day and I never knew or imagined that the entire WTC had collapsed.

Drs. Kelly and Prezant: Over the next days and weeks, there has been little time to grieve. Together with our staff at the Bureau of Health Services, FDNY members, retirees, and others, we have tried to meet the physical and mental health care needs of FDNY rescue workers. Each day we are thankful for being alive.

TABLE. Number and percentage of New York City Fire Department rescue workers who sought emergency medical care during the 24 hours after the collapse of the World Trade Center towers — New York City, September 11, 2001

Diagnostic category	No.	(%)*
Respiratory		
Respiratory tract irritation	50	(20.8)
Chest pain without myocardial infarction or ischemia	8	(3.3)
Pneumothorax without rib fracture	1	(0.4)
Inhalation injury requiring emergent tracheostomy, pneumothorax, and prolonged mechanical ventilation for adult respiratory distress syndrome	1	(0.4)
Respiratory arrest with bronchospasm	1	(0.4)
Asthma exacerbation	1	(0.4)
Trauma		
Soft tissue trauma		
Concussions	8	(3.3)
Contusions	19	(7.9)
Puncture wounds	2	(0.8)
Lacerations	2	(0.8)
Back pain	10	(4.2)
Extremity strains and sprains	29	(12.1)
Meniscus tears	2	(0.8)
Fractures		
Upper extremity fractures	5	(2.1)
Lower extremity fractures	7	(2.9)
Pelvic fractures	1	(0.4)
Rib fractures without pneumothorax	1	(0.4)
Rib fractures with pneumothorax	2	(0.8)
Cervical spine fracture	1	(0.4)
Burns		
Minor facial burns	3	(1.2)
Ophthalmic		
Eye irritation	25	(10.4)
Systemic		
Dehydration	5	(2.1)
Exposure†	70	(29.2)
Psychological		
Acute stress reaction	8	(3.3)
Total	**240**	

* Because each worker could have had more than one diagnosis, total percentage across all diagnostic categories could exceed 100%.

† During the 24 hours following the collapse of the World Trade Center towers, documentation of this category was limited. Rescue workers sought medical care in emergency departments and were released without hospital admission after treatment for any combination of mild exhaustion, dehydration, and eye and/or respiratory tract irritations.

Traumatic Injuries During the 3 Months After the Attacks (September 11–December 10, 2001)

Data for the first month following the attacks include those injuries occurring in the first 24 hours that resulted in medical leave. Compared with monthly mean incidence rates for the 9 months before the attacks, the incidence of crush injuries, lacerations, and fractures during the month after the attacks increased by 200% (from three to nine), 35% (from 37 to 50), and 29% (from 21 to 27), respectively, but then returned to levels similar to those observed before the attacks. Compared with the 9 months before the WTC attacks, monthly mean incidence decreased for contusions (from 86 to 67 [29%]), sprains and strains (from 364 to 200 [41%]), other orthopedic injuries (from 96 to 61 [35%]), and burns (from 43 to three [95%]). As of August 28, 2002, a total of 90 FDNY rescue workers were on medical leave or light duty assignments because of orthopedic injuries reported during the 3 months of activity at the WTC site.

Respiratory Illnesses During the 11 Months After the Attacks (September 11, 2001–August 22, 2002)

During the 48 hours after the attacks, approximately 90% of 10,116 FDNY rescue workers evaluated at the WTC site reported an acute cough often accompanied by nasal congestion, chest tightness, or chest burning; only three FDNY rescue workers required hospitalization. Compared with numbers of service-connected, respiratory medical leave incidents (n=393) during the 11 months preceding the attacks, the number of respiratory medical leave incidents (n=1,876) increased five-fold during the 11 months after the attacks. During February 2002, the incidence of new respiratory illness requiring either medical leave or light duty began to decrease and during May 2002 began to approach pre-attack incidence.

Respiratory illness with chest radiograph abnormalities: Two weeks after the attacks, one FDNY firefighter was admitted with acute eosinophilic pneumonia after repeated exposure to WTC dust (*1*). The firefighter fully recovered after a short course of corticosteroid treatment. In the 3 months after the attacks, 13 FDNY firefighters were treated for pneumonia (lobar consolidation with leukocytosis) with complete resolution following antibiotic therapy. This incidence was similar to that observed for the same period 1 year earlier. As of August 28, 2002, all 14 firefighters are asymptomatic and have returned to full duties.

WTC-related cough: During the 6 months after the attacks, 332 firefighters and one EMS worker had WTC-related cough severe enough to require ≥4 consecutive weeks of medical leave (*2*). Despite treatment of upper and lower aero-digestive tract irritation (i.e., sinusitis, gastroesophageal acid reflux, and/or asthma), 173 (52%) of 333 have shown only partial improvement of WTC-related cough and remain either on medical leave or light duty or are pending a disability retirement evaluation.

As of August 28, 2002, a total of 358 firefighters and five EMS workers remained on medical leave or light duty assignment because of respiratory illness that occurred after WTC exposure. On the basis of applications for respiratory

disability retirement benefits during the preceding 6 months, an estimated 500 FDNY firefighters (4% of the 11,336 total FDNY firefighter workforce) might eventually qualify for disability retirement because of persistent respiratory conditions.

Stress-Related Illnesses During the 11 Months After the Attacks (September 11, 2001–August 22, 2002)

During the 11 months after the attacks, 1,277 stress-related incidents were observed among FDNY rescue workers, a 17-fold increase compared with the 75 stress-related incidents reported during the 11 months preceding the attacks. As of August 28, 2002, a total of 250 FDNY rescue workers remain on leave with service-connected, stress-related problems. Of these, 37 also have respiratory problems.

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Editorial Note: During the 3 months after the WTC attacks, medical leave incidents were increased for eye irritations, fractures, crush injuries, and lacerations but decreased for other traumatic injuries. These findings probably resulted from 1) lack of adequate eye protection against fine airborne particles, 2) inability of work gloves to reduce injuries while maintaining comfort and dexterity, 3) effective use of thermal personal protective equipment despite an extremely hazardous environment, 4) prevention of major injuries because of safe work practices, and 5) underreporting of minor injuries because of the dedication of this workforce to remain on the job at the WTC site.

Although approximately 90% of FDNY rescue workers reported a new or worsening cough during the 48 hours after the attacks, only three FDNY rescue workers required hospitalization for acute inhalation injury, and no FDNY rescue worker with chest pain had coronary artery disease. These findings are related to FDNY medical policy that does not allow firefighters to perform fire-fighting duties unless cardiopulmonary function is normal. During the 11 months after the WTC attacks, the number of medical leave incidents for respiratory illnesses increased, and approximately 500 FDNY firefighters might qualify for retirement disability benefits for new onset asthma and other reactive airway diseases. Increased bronchial responsiveness also has been found in firefighters with WTC-related cough. These findings might reflect delayed or progressive inflammation of the respiratory tract with or without repeated exposures and the synergistic inflammatory effects of sinusitis and/or gastroesophageal reflux.

The high incidence of respiratory problems and related medical leave among FDNY rescue workers demonstrates the need for adequate respiratory protection. During the collapse, 52% of workers did not wear respirators, and 38% did not wear respirators for the rest of the first day (*3*). In addition, most of those reporting the use of a respirator during the first day used only a disposable paper dust mask that was neither NIOSH-certified nor fit-tested. However, despite widespread acknowledgment that rescue workers at future disasters be provided with respiratory protection as soon as possible, such plans will be successful only if barriers to use, such as supply, heat stress and discomfort, communications, training, compliance, and supervision, are resolved.

The increase in stress-related medical leave did not occur in large numbers until months after the attacks. Repeated exposures at the site and the increasing number of funerals and memorial services that firefighters attended during the next 11 months might have contributed to stress-related problems. In July 2002, new cases began to decline, but previous incidents of terrorism suggest that cases might increase after the 1-year anniversary of the attacks. Especially for stress-related problems, these numbers do not reflect the full volume of health evaluations and treatment activity because many workers report symptoms and seek treatment while remaining on full duty.

The findings in this report are subject to at least one limitation. Because of disaster conditions after the attacks, some rescue workers who presented to hospitals or treatment centers for emergency medical treatment and were treated and released without admission and never required medical leave might have remained unreported. This limitation would only apply to minor injuries.

One year after the WTC attacks, FDNY rescue workers continue to recover from orthopedic, respiratory, and stress-related problems. The findings in this report demonstrate the need to provide improved personal protective equipment (especially eye, hand, and respiratory protection) and continued medical monitoring, treatment, and counseling for all rescue workers exposed to disasters.

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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.

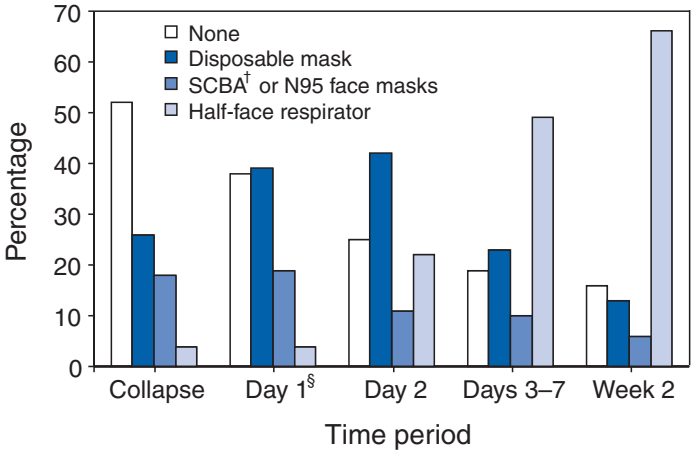
The respiratory protection section of the questionnaire elicited firefighter respirator use during each of the five time periods: during the collapse, day 1, day 2, days 3–7, and week 2 following the collapse. The number of participants present each day was calculated and used to generate rates of respirator 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

This report was based on data contributed by S Lenhart, MSPH, Div of Surveillance, Hazard Evaluations and Field Studies, National Institute for Occupational Safety and Health, CDC.

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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.

Prevalence of eye irritation, nose/throat irritation, cough, nausea, and shortness of breath was significantly higher ($p \leq 0.05$) for staff at high school A and college A, compared with staff at high school B and college B after September 11 (Table 1). Approximately 4–6 months after the attacks, 5%–30% of employees in high school A and college A had persistent physical symptoms (Table 2); the majority of these symptoms were significantly higher ($p \leq 0.05$) in high school A and college A than in the comparison schools.

Approximately one third (33%) of high school A and 24% of college A respondents reported symptoms consistent with major depression; 23% of high school A and 15% of college A respondents had symptoms consistent with PTSD. Rates for symptoms consistent with depression and PTSD from the survey were significantly higher in high school A and college A compared with high school B and college B (Table 2).

Reported by: *BP Bernard, MD, SL Baron, MD, CA Mueller, MS, RJ Driscoll, PhD, LC Tapp, MD, KM Wallingford, MS, AL Tepper, PhD, National Institute for Occupational Safety and Health, CDC.*

Editorial Note: The findings from these surveys indicate that 4–6 months after the September 11 terrorist attacks, workers surveyed near the WTC site had substantial rates of irritative, respiratory, and mental health symptoms and lost work time, compared with similar workers surveyed ≥5 miles from the WTC site. These findings indicate how the impact of the WTC attacks extended beyond the WTC site to affect the health of persons working nearby.

TABLE 1. Number and percentage of high school and college staff reporting physical or mental health symptoms after the World Trade Center (WTC) attacks, by symptom — New York City, January and March 2002

	High school A (in proximity to WTC site) (n=224)		High school B (comparison site) (n=155)		College A (in proximity to WTC site) (n=374)		College B (comparison site) (n=204)		High schools A to B		Colleges A to B	
Symptom	**No.**	**(%)**	**No.**	**(%)**	**No.**	**(%)**	**No.**	**(%)**	**PR***	**(95% CI†)**	**PR**	**(95% CI)**
Eye irritation	128	(59)	57	(38)	224	(62)	70	(36)	1.6	(1.2–2.0)§	1.8	(1.4–2.1)§
Nose/throat irritation	136	(65)	57	(39)	219	(62)	72	(37)	1.6	(1.3–2.1)§	1.7	(1.4–2.1)§
Cough	138	(63)	57	(38)	216	(60)	72	(36)	1.7	(1.3–2.1)§	1.7	(1.4–2.0)§
Shortness of breath	75	(35)	31	(21)	130	(36)	31	(16)	1.7	(1.2–2.4)§	2.3	(1.6–3.3)§
Chest tightness	59	(28)	28	(19)	111	(31)	24	(12)	1.5	(1.0–2.2)	2.5	(1.7–3.8)§
Wheezing	42	(20)	21	(14)	72	(20)	15	(8)	1.4	(0.9–2.3)	2.6	(1.6–4.5)§
Nausea	40	(19)	16	(11)	60	(17)	15	(8)	1.7	(1.0–2.9)§	2.2	(1.3–3.8)§
Indigestion	65	(30)	32	(22)	97	(27)	42	(21)	1.4	(1.0–2.0)	1.3	(1.0–1.8)
Depression¶	72	(34)	28	(18)	85	(24)	34	(17)	1.9	(1.3–2.8)§	1.4	(1.0–2.0)
Post-traumatic stress disorder**	49	(23)	9	(6)	53	(15)	17	(8)	3.8	(1.9–7.5)§	1.7	(1.0–2.9)§

* Prevalence ratio.
† Confidence interval.
§ Statistically significant ($p \leq 0.05$).
¶ Defined as a score of ≥22 for modified Center for Epidemiologic Studies scale.
** Defined as a person who responded affirmatively (an answer of "moderately," "quite a bit," or "extremely") to questions according to the Diagnostic and Statistical Manual of Mental Disorders-IV criteria (*3*).

TABLE 2. Number and percentage of high school and college staff reporting persistent physical symptoms* after the World Trade Center (WTC) attacks, by symptom — New York City, January and March 2002

	High school A (in proximity to WTC site) (n=224)		High school B (comparison site) (n=155)		College A (in proximity to WTC site) (n=374)		College B (comparison site) (n=204)		High schools A to B		Colleges A to B	
Symptom	**No.**	**(%)**	**No.**	**(%)**	**No.**	**(%)**	**No.**	**(%)**	**PR†**	**(95% CI§)**	**PR**	**(95% CI)**
Eye irritation	62	(29)	22	(15)	112	(31)	20	(10)	2.0	(1.3– 3.0)¶	3.1	(2.0– 4.8)¶
Nose/throat irritation	65	(31)	25	(17)	102	(29)	19	(10)	1.8	(1.2– 2.7)¶	3.0	(1.9– 4.7)¶
Cough	59	(27)	15	(10)	101	(28)	25	(13)	2.7	(1.6– 4.6)¶	2.2	(1.5– 3.3)¶
Shortness of breath	40	(19)	10	(7)	65	(18)	9	(5)	2.8	(1.4– 5.4)¶	4.0	(2.0– 7.8)¶
Chest tightness	30	(14)	6	(4)	49	(14)	5	(3)	3.5	(1.5– 8.2)¶	5.4	(2.2–13.3)¶
Wheezing	24	(11)	4	(3)	37	(10)	5	(3)	4.2	(1.5–11.9)¶	4.1	(1.6–10.1)¶
Nausea	17	(8)	6	(4)	19	(5)	4	(2)	1.9	(0.8– 4.8)	2.6	(0.9– 7.6)
Indigestion	27	(13)	10	(7)	44	(12)	6	(3)	1.8	(0.9– 3.7)	4.2	(1.8– 9.6)¶

* Those reporting "yes" to symptoms after September 11, 2001, and "yes" to either symptom before September 11 with worsening or new onset of symptoms with "no change" or worsening of symptoms. Excludes those with pre-existing symptoms who reported "no change" after September 11.
† Prevalence ratio.
§ Confidence interval.
¶ Statistically significant ($p \leq 0.05$).

Mucous membrane and respiratory symptoms among the survey participants described in this report, the majority of whom were present during the September 11 attacks, might have resulted initially from exposure to multiple environmental contaminants (e.g., smoke, respirable airborne particles, fine dust, and fire combustion products) generated by the collapse of the towers and ensuing fires. Information is limited concerning health effects associated with complex mixed environmental exposures (e.g., those that occurred during and after the WTC attacks).

Approximately 30% of workers included in this survey reported persistent physical symptoms several months after the initial event. The persistence of symptoms in certain persons might be explained by several factors, including differences in the initial exposure, individual susceptibility, existing medical conditions, and factors related to social support or individual stressors.

The results reported here indicate that many high school and college workers near the WTC site experienced symptoms consistent with PTSD and depression. Proximity to the WTC site also was a significant finding for "probable PTSD" (a slightly different case definition using the same PTSD scale) among NYC residents in a recent web-based epidemiologic study (*4*).

The findings in this report are subject to at least two limitations. First, responses to extraordinary traumatic events might provoke a range of reactions, and symptoms alone are not adequate to document fully psychologic or physical illness. Second, because of the low response rate for colleges A and B, the percentages and prevalence ratios should be interpreted with caution because of potential participation bias.

Further investigations using full clinical diagnostic assessment might be useful in determining the breadth and scope of illness in persons with persistent symptoms. Because mental health and physical symptoms can persist for extended periods after a disaster, persons who continue to experience symptoms should seek professional assistance. Counseling services should continue to target those who are vulnerable to depression and PTSD, particularly those who have lost family or friends, those who do not have a social network, and those who witnessed the attacks (*5,6*).

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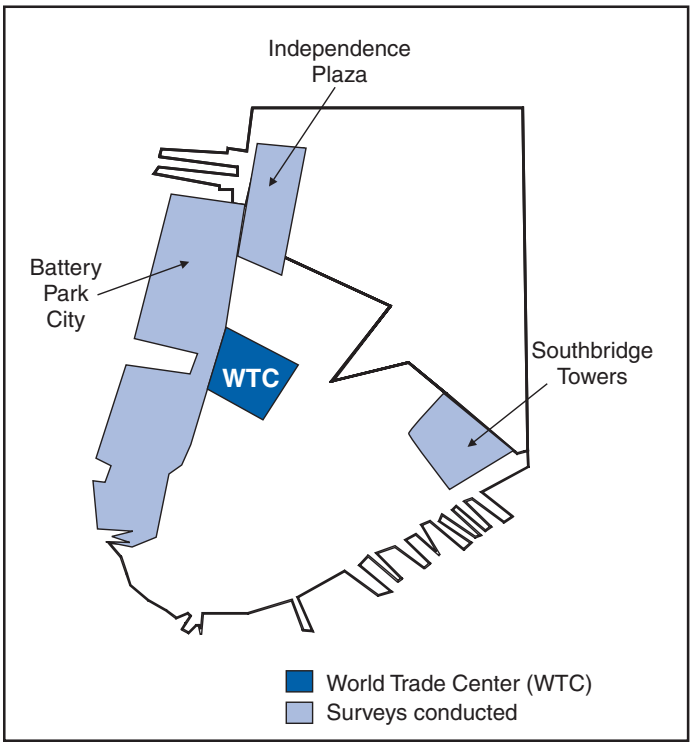
Community Needs Assessment of Lower Manhattan Residents Following the World Trade Center Attacks — Manhattan, New York City, 2001

On September 11, 2001, terrorists attacked and destroyed the World Trade Center (WTC) in New York City (NYC). An estimated 2,819 persons were reported killed in the attacks; many others were injured (Office of the Chief Medical Examiner, New York City Department of Health and Mental Hygiene [NYCDOHMH], unpublished data, 2002). An estimated 25,000 persons living nearby in lower Manhattan were affected both physically and emotionally. Many persons witnessed the attacks; lost family and friends; were exposed to smoke, dust, and debris; and evacuated their homes. To identify the health-related needs and concerns of persons residing near the attack site, NYCDOHMH, in collaboration with CDC, surveyed persons residing in areas immediately surrounding the WTC site. The primary purpose of the survey was to gather information to set priorities and direct public health interventions. This report summarizes findings from the assessment, which indicate that a large proportion of respondents had physical and psychological symptoms potentially associated with the exposure and needed information to address their health and safety concerns. On the basis of the results of the survey, NYCDOHMH responded to resident concerns, helped reduce exposure to dust and debris, and provided information about mental health resources.

The survey was conducted door-to-door in three residential areas in lower Manhattan: Battery Park City, Southbridge Towers, and Independence Plaza (populations: approximately 8,000, 2,000, and 2,300, respectively) (Figure). These areas represented compact, well-defined neighborhoods comprising approximately 50% of the residential population of lower Manhattan. On the basis of data from the NYC Department

FIGURE. Areas selected for door-to-door survey of persons residing in lower Manhattan after September 11, 2001, attacks on the World Trade Center — New York City, October 25–November 2, 2001



of City Planning and on information provided by building managers, a representative random sample of households were selected, yielding a final sample size of ≥100 households per area. Survey teams composed of NYCDOHMH and CDC staff interviewed one adult (i.e., person aged ≥18 years) in each household selected.

A standardized questionnaire was developed to obtain information about household demographics, exposure to the WTC attack, physical and mental health status, access to services, and urgent needs and concerns. The questionnaire included the Post-Traumatic Stress Disorder (PTSD) checklist, a validated 17-item screening instrument for symptoms of PTSD based closely on DSM-IV criteria (*1*). Data were analyzed using Epi-Info 6.04 and SAS 8.2. Data from the three surveyed areas were combined and weighted on the basis of the total number of occupied households in each neighborhood.

With the assistance of building managers and staff, tenant associations, and other community organizations, survey teams succeeded in contacting 485 of 990 households that had been selected randomly. Uncontacted households included those that were not yet reoccupied and those whose residents were unavailable when visited. A total of 71 persons declined to participate; the overall participation rate was 85.4%. During October 25–November 2, 2001, a total of 414 surveys were completed, including 145 in Battery Park City, 157 at Southbridge Towers, and 112 at Independence Plaza. Overall, an estimated 75.1% (95% confidence interval [CI]=71.8%–78.4%) of households were evacuated after the attacks. Respondents had a median age of 45 years (range: 18–92 years), and 16.4% (95% CI=12.7%–20.1%) had children aged <18 years. An estimated 55.2% (95% CI=50.1%–60.4%) of the population witnessed the collapse of the WTC towers, 29.0% (95% CI=24.2%–33.7%) witnessed persons being injured or killed, and 48.1% (95% CI=42.9%–53.2%) knew someone who died as a result of the attacks.

Although many households lost utility services (i.e., water, electricity, and gas) after September 11, almost all had functional services at the time of interview; however, some households still did not have telephone service (15.5%; 95% CI=12.1%–18.8%). Approximately half of the population reported feeling safe in their homes; those not feeling safe were most concerned about air quality and surface dust. Information about proper cleaning procedures was received by 61.2% (95% CI=56.3%–66.2%), and 45.2% (95% CI=39.9%–50.6%) reported that their apartments had been cleaned according to recommended methods of wet mopping hard surfaces and using high-efficiency particulate air (HEPA) filter vacuums on carpeting. Residents also indicated a need for further information regarding exposure to dust and debris from the WTC and its effect on health, recommendations for proper clean up, and availability of both mental health and relief services.

Symptoms reported most frequently that developed or increased after September 11 were nose or throat irritations (65.8%; 95% CI=60.9%–70.7), eye irritation or infection (49.7%; 95% CI=44.6%–54.9%), and coughing (46.5%; 95% CI=41.3%–51.6%). At the time of the interviews, these symptoms continued to be a problem among approximately 82% of the adult population. Few respondents reported lack of access to medical care (6.6%; 95% CI=4.1%–9.2%), yet 13.6% (95% CI=9.6%–17.5%) reported problems filling prescriptions, primarily because of problems with phones and transportation.

When asked about symptoms of PTSD, an estimated 38.9% (95% CI=33.9%–44.0%) of the adult population scored above the screening cutoff of 43, indicating a need for further mental health evaluation and a potential for PTSD. An estimated 36.8% (95% CI=28.9%–44.7%) of this population had received some type of supportive counseling, compared with 22.7% (95% CI=16.9%–28.4%) of the population with scores below the cutoff. Overall, an estimated 28.1% (95% CI=23.4%–32.8%) of the adult population had received some type of supportive counseling. A total of 38.7% (95% CI=33.6%–43.9%) thought they would benefit from any or

additional supportive counseling; of these, 34.0% (95% CI=25.8%–42.3%) reported not having adequate access to this kind of support. When asked about alcohol use, 14.0% (95% CI=10.2%–17.7%) reported having used alcohol more than they meant to since the attack, and 6.5% (95% CI=3.7%–9.2%) felt that they needed to decrease their drinking since the attack.

On the basis of the survey results, NYCDOHMH initiated focused outreach in lower Manhattan neighborhoods through presentations with tenant associations and community groups to share information and provide a forum for questions and concerns. Materials were developed and disseminated regarding environmental issues and related health problems, current air and dust testing results and their implications, recommendations for cleaning up and reducing further exposures, psychological effects, and availability of relief services. Materials were distributed to residential buildings and community organizations, and were made available at public places (e.g., libraries, stores, and restaurants) and on NYCDOHMH's website (http://www.nyc.gov/html/doh/pdf/chw/needs1.pdf). NYCDOHMH monitored efforts to maintain dust suppression in the areas close to the WTC site and communicated closely with other agencies overseeing the cleanup process around the site. The assessment findings also were shared with Project Liberty, a disaster recovery program funded by the Federal Emergency Management Agency that provides outreach, crisis counseling, and public education services to persons affected by the WTC disaster.

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Editorial Note: This community assessment documented the public health impact of the WTC attacks on persons living nearby in lower Manhattan. Although basic community services were available 6 weeks after the attacks, persistent physical and psychological symptoms were reported among local residents. Residents also expressed concern about air quality and potential short- and long-term health effects, especially after Environmental Protection Agency reports of the presence of asbestos, particulate matter, and volatile organic compounds at the WTC site. The high proportion of the local population that reported experiencing health problems potentially related to respiratory irritants supported this concern. As with other needs assessments conducted soon after a disaster (*2,3*), this survey provided systematically collected information that could be used to respond to public concerns and to address the health and mental health needs of this population.

Although the air quality in lower Manhattan improved with time, resulting in a reduction of some of the immediate physical impact from the attacks, the psychological impact remained. The estimated proportion of residents with increased potential for PTSD is consistent with estimates of PTSD following other disasters (*4,5*). These estimates suggest that thousands of persons residing in lower Manhattan might have been at risk for PTSD and could potentially benefit from receiving supportive mental health services. A central component to outreach in this community involved education about the benefits and availability of supportive counseling services available through Project Liberty.

The findings in this report are subject to at least four limitations. First, the survey did not include persons who had not yet returned to their homes. Those who delayed returning might have had more serious psychological or physical symptoms. Second, because the survey did not include this population, the estimates for the mean time of evacuation also are underestimated. Third, no background or comparison data were available to validate the self-reported assessment of health effects, and these assessments were not verified by health-care providers. Finally, the indicator of potential for PTSD was not diagnostic.

In response to the assessment, NYCDOHMH conducted extensive outreach, developed and disseminated informational materials, and provided referral services to meet community needs. This assessment and its follow-up activities also provided an opportunity for persons living near the WTC site to voice their concerns to government agencies in the aftermath of the disaster. NYCDOHMH was able to provide an important service for this community by giving local residents timely and comprehensive information. Feedback received from residents highlights the need to conduct a community assessment as soon as possible after a disaster.

Because the needs and health effects following a disaster often vary over time, multiple community assessments might be necessary to monitor these changes and to reach different populations if evacuations have occurred. The availability of standardized assessment tools and local health professionals trained in rapid needs assessment procedures could facilitate understanding a community's post-disaster needs.

Acknowledgments

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Syndromic Surveillance for Bioterrorism Following the Attacks on the World Trade Center — New York City, 2001

Immediately after the September 11, 2001, terrorist attacks on the World Trade Center (WTC), the New York City Department of Health and Mental Hygiene (NYCDOHMH) was concerned about the possibility of a secondary attack with a biologic agent. Because NYCDOHMH lost communications as a result of the attacks, concern arose that this disruption would affect the ability to recognize a bioterrorist event. To address this concern, NYCDOHMH quickly implemented a syndromic surveillance system in hospital emergency departments (EDs) to identify a large-scale bioterrorist event and other health conditions related to the WTC attacks. This report describes the operational and maintenance aspects of conducting syndromic surveillance for bioterrorism (BT) and demonstrates the limitations of drop-in systems that rely on manual data collection. Health departments that are establishing early warning systems for BT should consider seeking routinely collected electronic data.

On the evening of September 11, NYCDOHMH, in collaboration with epidemiologists from CDC, began planning for the immediate implementation of an ED-based syndromic surveillance system. The system design was based on drop-in surveillance systems deployed by CDC at the World Trade Organization Ministerial (Seattle, Washington) in 1999, the Superbowl (Tampa, Florida) in 2001, and other venues.

A total of 15 New York City (NYC) emergency departments (EDs) were selected as sentinel sites on the basis of their patient volumes and locations; all agreed to participate. A one-page form was created for coding each ED visit into one of 12 syndromes; seven symptoms represented clinical presentations that might result from exposure to a bioterrorist agent, four represented possible sequelae of the WTC attacks (non-BT), and a "none of the above" category represented patients who did not have either (Table). On the basis of their clinical judgment, health-care providers were asked to choose the syndrome that best represented the patient's primary diagnosis. The form also recorded the patient's name, hospital, medical record number, sex, date, age, home postal code, work postal code, and whether the patient was in the vicinity of the WTC on September 11. By the use of a modification of the CUSUM method (*1*), citywide and hospital aberrations were calculated, and a modification of SaTScan (*2*) was used to detect spatial patterns by hospital and home postal code. To account for fluctuations in ED volume, daily counts of each syndrome of interest were divided by the "none of the above" category. This Syndrome to None Ratio (SNR) was then used in the CUSUM and SaTScan analyses. Both techniques compared the daily ratio to its cumulative baseline by hospital, hospital cluster, or postal-code cluster. Alarms were generated when the SNR was significantly higher for the day in question compared with the recent past. The patient's name was not entered into the database but was obtained from medical records to investigate alarms.

On the evening of September 13, medical epidemiologists visited each ED to orient and train hospital staff. Field teams composed of up to three CDC Epidemic Intelligence Service Officers (EISOs) per hospital were dispatched on September 14 and provided 24-hour coverage at 15 hospitals for the initial 2 weeks and 18-hour coverage at 12 hospitals for the remainder of the 30-day surveillance period. Each team performed data entry onsite, ensured form completion when necessary, and conducted follow-up of patients to investigate alarms. Data were sent to NYCDOHMH's temporary headquarters by 9:00 a.m. each morning. Data collection and analysis were begun on September 13. Completeness of reporting was monitored by dividing the number of daily records by the daily ED census obtained from each hospital's logbook.

During September 13–October 12, a total of 68,546 ED visits were recorded. A low completion of forms occurred on September 13 before the deployment of EISOs and again on September 28, when the change in surveillance occurred. Patient visits were recorded from every NYC home postal code. Coverage, as determined by the ratio of visits by patients from the same postal code to the population of that area, was highest in Manhattan and the Bronx and lowest in Queens. Completeness of reporting ranged from 72% to 97% (mean: 90%) during the first 2 weeks, when hospital surveillance staffing was 24 hours per day, and from 65% to 90% (mean: 82%) during the second 2 weeks, when 18-hour ED surveillance coverage was employed. A total of 48,769 (71.1%) visits were

TABLE. Definitions and frequency of syndromes under surveillance — New York City, 2001

Syndrome	Description	Potential BT agent/exposure	No.
Anxiety	Anxiety reaction including somatic complaints, insomnia	None	905
Asthma	Exacerbation of underlying respiratory condition	None	3613
Botulism-like	Cranial nerve impairment with weakness	Botulinum toxin	7
Death	Unexplained death with history of fever	Many	1
Gastrointestinal	Diarrhea/gastroenteritis (including vomiting or abdominal cramps)	Food/water	2,096
Inhalational	Smoke or dust inhalation	None	371
Neurologic	Meningitis, encephalitis, or unexplained acute encephalopathy	Venezuelan Equine Encephalitis	46
Rash	Rash with fever (both must be present)	Smallpox	109
Respiratory	Upper- or lower-respiratory infection with fever	Anthrax, plague, tularemia	1,985
Sepsis	Sepsis or nontraumatic shock	Many	177
Trauma	Trauma	None	9,001
None of the above	Not in any of the above categories	None	48,769
Missing	Form left blank	—	1,467

coded as "none of the above," followed by 13,890 (20.3%) in the non-BT syndrome group, 4,421 (6.4%) in the potential BT syndrome group, and 1,467 (2.1%) with no code checked.

Over the 30-day surveillance period, the mean SNR for trauma was the highest of any syndrome (18.6%), followed by exacerbation of a chronic respiratory condition (7.6%). Diarrhea/gastroenteritis and upper- and lower-respiratory infections with fever were the most common syndromes possibly associated with BT, with mean SNRs of 4.4% and 4.2%, respectively. Respiratory infection and rash were reported most often in children, with 1,323 (67%) respiratory syndrome visits and 63 (59%) rash syndrome visits occurring among children aged <15 years. Persons aged 25–64 years accounted for 298 (80%) inhalational visits and 673 (75%) anxiety visits. Binary logistic odds ratios (ORs) and 99.9% confidence intervals (CIs) were calculated to compare SNRs with patients reporting proximity to the WTC on the day of the attacks (i.e., if the patient was south of Canal Street). The analyses were repeated for home postal codes within a 2-mile radius of the WTC. Persons who were near the WTC on September 11 or resided in the area, as defined by a 2-mile radius around the site, were no more likely to have a syndrome of BT interest than those without such proximity. Persons reporting proximity to the WTC on September 11 were 61.5 (99.9% CI=44.7–84.7) times more likely to visit an ED for smoke/dust inhalation than the "none of the above" category compared with patients not reporting such proximity. ORs for anxiety, trauma, and asthma were 8.3 (99.9% CI=6.2–11.0), 1.9 (99.9% CI=1.6–2.2), and 1.8 (99.9% CI=1.4–2.3), respectively. The only significant OR for home postal code within 2 miles of the WTC was for smoke/dust inhalation, with ED visits from these postal codes having a 2.4 (99.9% CI=1.7–3.4) greater likelihood of this syndrome compared with the "none of the above" category.

Two types of alarms were investigated: 1) individual hospital-level alarms as determined by CUSUM and 2) geographically localized alarms by postal code and hospital as determined by SaTScan. A total of 91 alarms were registered for the five syndromes of BT interest (respiratory, rash, gastrointestinal, neurologic, and sepsis), 53 by CUSUM, and 38 by SaTScan. At least one alarm occurred on 24 of the 27 surveillance analysis days. Gastrointestinal (n=26) and respiratory (n=25) alarms were the most frequent syndromes triggering an investigation. Approximately 7% of alarms were attributed to errors in coding and data entry. Single cases of botulism-like illness and unexplained death with fever were detected and investigated. Evaluations of alarms did not reveal any similarity in the cases or final diagnoses suggestive of a natural outbreak or bioterrorist attack.

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Editorial Note: This report highlights the need for more experience with and evaluation of syndromic surveillance. Immediately after the attacks on the WTC, public health officials in NYC went on heightened alert for a bioterrorist attack. A drop-in surveillance system at sentinel EDs was established quickly and sustained during the immediate aftermath and was useful in assuring both public health and government officials that no large-scale aerosolized biologic agents had been released in NYC.

The syndromes of BT concern comprised a minority (6.4%) of ED visits observed. Using SNR as the measure for comparison was necessary to account for differences in ED volume based on day of week and the reduction in participating hospitals that occurred after the first 2 weeks. The 68,547 visits recorded during the 30-day surveillance were an adequate sampling, comprising 23% of the average monthly citywide ED visits (Greater New York Hospital Association unpublished data, 2001). Visits were concentrated in Manhattan, particularly in the immediate vicinity of the WTC. Proximity to the WTC was strongly associated with ED visits for smoke/dust inhalation, presumably because of the tremendous amount of particulate matter released by the explosion and collapse of the WTC buildings. No syndrome of BT interest was associated with either measure of proximity.

Several challenges and limitations in conducting syndromic surveillance were revealed in this effort. First, the system required significant technical and staff resources, especially for the ED-based staff, which would have severely disrupted NYCDOHMH core public health activities were it not for the deployment of approximately 45 EISOs from CDC. Field staff required cell phones with two-way radios, daily transportation to and from hospitals, and data-processing support from NYCDOHMH-based staff. The number of staff needed to operate the system was not sustainable beyond the 30-day period. Second, rapid implementation required personnel to resort to manual data entry, resulting in coding errors. Both these errors and insufficient baseline data contributed to false alarms. Third, the parameters of this system assumed that patients with prodromal symptoms of an illness caused by a bioterrorist agent would seek care in EDs. Although the system was in place, it did not detect the outbreak of anthrax among recipients of anthrax-contaminated letters in NYC in mid-September (*3*). Six of the seven patients diagnosed with cutaneous anthrax in NYC did not seek care in EDs; however, syndromic surveillance in NYC was not designed to detect single cases or cutaneous cases but rather an outbreak due to an aerosolized release of a biologic agent, in which early recognition could prevent mortality. Fourth, a total of 15 EDs were chosen as sentinel sites to be geographically representative of the NYC population. However, some areas of the city were not well represented, and the system could not account for potentially exposed persons residing outside of the five NYC boroughs. Finally, because investigations of alarms revealed substantial heterogeneity of symptoms and diagnoses within syndromes, deciding when to pursue investigations with chart review was especially difficult. Although trained hospital staff reviewed medical records and received clinical status updates, only time-consuming laboratory tests provided assurance that no agent of BT concern was implicated. Therefore, it difficult to determine whether such ED-based systems can detect a large-scale bioterrorist attack before clinicians report suspected or confirmed cases.

Although costly and resource intensive, this EISO-based system was warranted given the unprecedented nature of the WTC attacks, the concerns about a secondary attack with a biologic agent, and the need to rapidly establish a surveillance system to monitor unusual disease occurrences or clusters due to the breakdown of NYCDOHMH's routine communication systems. The system has been replaced by an expanded and automated syndromic surveillance system using electronic ED chief complaint logs. As more state and local health departments are implementing syndromic surveillance systems, public health officials should consider adopting a regional approach with standardized coding algorithms; expansion of data sources to include laboratory, radiology, and outpatient information; and discussions about collaborative methods for rapidly investigating statistically generated aberrations.

Acknowledgments

The findings in this report are based on data and services contributed by emergency department and infection control staff at the 15 sentinel New York City hospitals, the emergency response teams of the New York City Department of Health and Mental Hygiene, and EIS officers from CDC.

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Deaths in World Trade Center Terrorist Attacks — New York City, 2001

On September 11, 2001, terrorists flew two hijacked airplanes into the World Trade Center (WTC) in lower Manhattan in New York City (NYC), destroying both towers of the WTC. This report presents preliminary vital statistics on the deaths caused by the terrorist attacks and describes the procedures developed by the New York City Department of Health and Mental Hygiene (NYCDOHMH) to issue death certificates in response to the attacks. These data underscore the need for legal mechanisms to expedite the issuance of death certificates in the absence of human remains and the need for vital registration systems that can be relocated in case of emergency.

As of August 16, 2002, a total of 2,726 death certificates related to the WTC attacks had been filed. All but 13 persons died on September 11; of the 13 persons who were injured on September 11 and died subsequently, three persons died in other states, one each in Massachusetts, Missouri, and New Jersey. Of these 2,726 decedents, 2,103 (77%) were males and 623 (23%) were females. The median age for these decedents was 39 years (range: 2–85 years); the median age was 38 years for females (range: 2–81 years) and 39 years for males (range: 3–85 years). Three persons were aged <5 years, and three were aged ≥80 years. These data represent 97% of the estimated 2,819 WTC deaths; fewer death certificates have been issued than the estimated number of decedents because some families have not yet requested certificates, and investigations into several requests are still in progress.

Of these 2,726 decedents, 1,659 (61%) were non-Hispanic white males, 407 (15%) were non-Hispanic white females, 177 (6%) were Hispanic males, 81 (3%) were Hispanic females, 136 (5%) were non-Hispanic black males, 79 (3%) non-Hispanic black females, 122 (4%) were Asian/Pacific Islander (API) males, and 54 (2%) were API females. A total of 1,837 (67%) had graduated from college or had postgraduate education (males, 69%; females, 63%) (Table 1).

A total of 2,158 (79%) decedents were born in the 50 U.S. states, compared with 59% of the NYC population (*1*). A total of 568 (21%) decedents were born outside the 50 states, including the United Kingdom (n=56), India (n=36), Puerto Rico (n=34), the Dominican Republic (n=26), and Japan (n=25). By place of residence, as reported on the death certificates, 1,169 (43%) decedents were residents of NYC, 593 (22%) were residents elsewhere in New York (NY) state, and 674 (25%) were residents of New Jersey (Table 2). A total of 27 (1%) were residents of foreign countries. A total of 90 decedents were residents of Massachusetts, the origin of the two airplanes that struck the WTC, and 29 were residents of California, the destination of the flights.

NYCDOHMH processing of death certificates includes assignment of underlying cause-of-death codes. The NYC

TABLE 1. Number of deaths* at World Trade Center, by racial/ethnic group, education, and sex† — New York City, September 11, 2001

Racial/Ethnic group/ education	Sex		
	Male	Female	Total
Hispanic			
Less than high school	9	2	**11**
High school	68	19	**87**
Some college	30	26	**56**
College or more	69	34	**103**
Unknown	1	—	**1**
Total	**177**	**81**	**258**
White, non-Hispanic			
Less than high school	5	1	**6**
High school	246	100	**346**
Some college	199	36	**235**
College or more	1,195	267	**1,462**
Unknown	14	3	**17**
Total	**1,659**	**407**	**2,066**
Black, non-Hispanic			
Less than high school	3	—	**3**
High school	44	24	**68**
Some college	21	8	**29**
College or more	65	44	**109**
Unknown	3	3	**6**
Total	**136**	**79**	**215**
Asian/Pacific Islander			
Less than high school	—	—	**—**
High school	8	2	**10**
Some college	4	3	**7**
College or more	109	47	**156**
Unknown	1	2	**3**
Total	**122**	**54**	**176**
Other and unknown			
Less than high school	—	—	**—**
High school	1	1	**2**
Some college	1	1	**2**
College or more	7	—	**7**
Unknown	—	—	**—**
Total	**9**	**2**	**11**
All racial/ethnic groups			
Less than high school	**17**	**3**	**20**
High school	**367**	**146**	**513**
Some college	**255**	**74**	**329**
College or more	**1,445**	**392**	**1,837**
Unknown	**19**	**8**	**27**
Total	**2,103**	**623**	**2,726**

* Includes three deaths outside New York City.
† Preliminary data as of August 16, 2002.

TABLE 2. Number of deaths* at World Trade Center, by state and county of residence† — New York City, September 11, 2001

Residence	No.	Residence	No.
Arizona	1	Ohio	1
California	29	Pennsylvania	27
Colorado	2	Rhode Island	5
Connecticut	63	Tennessee	1
Delaware	1	Texas	2
Florida	2	Utah	1
Georgia	4	Virginia	3
Illinois	9	Foreign Country	27
Indiana	1	Australia	2
Louisiana	1	Bermuda	1
Maine	3	Canada	5
Maryland	3	El Salvador	1
Massachusetts	90	Germany	4
Michigan	2	Israel	1
Missouri	2	Japan	2
New Hampshire	9	United Kingdom	11
New Jersey	674	**Total**	**2,726**
New Mexico	1		
New York	1,762		
New York City	1,169		
Manhattan	338		
Bronx	91		
Brooklyn	291		
Queens	257		
Staten Island	192		
Rest of New York State	593		

* Includes three deaths outside New York City.
† Preliminary data as of August 16, 2002.

Office of Chief Medical Examiner (OCME) classified all reported deaths as homicides*. (Death certificates for the 10 terrorists on the two airplanes have not been issued and are not included in these data; these deaths might be classified as suicides.) As of August 22, 2002, OCME had issued 2,734 death certificates, including 1,373 for decedents whose remains had been found and 1,361 for decedents whose remains had not been found; the discrepancy might reflect the later date, and these data might contain some duplications. Methods used to identify decedents included DNA (645), dental radiographs (188), fingerprints (71), personal effects (19), and photographs (16). Multiple methods were used to identify 407 decedents, and 966 were identified by a single method (Shiya Ribowsky, OCME, personal communication, 2002). Death certificates listed the cause of death as "physical injuries (body not found)" for decedents whose remains were not found and were specific when remains were found (e.g., "blunt trauma to head, trunk, and extremities").

*The new terrorism codes issued by CDC's National Center for Health Statistics (NCHS) did not exist when the WTC certificates were first received; to identify these deaths, a unique code was developed and used, which will be changed to conform to the new NCHS codes.

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Editorial Note: NYC is an independent vital registration jurisdiction; all of its vital statistics and vital records functions are concentrated in NYCDOHMH's headquarters building, which is 10 blocks (0.4 miles; 0.7 kilometers) from the WTC site. Following the attacks, the area was evacuated; within 6 hours, the Office of Vital Records (OVR) moved its death registration function to another location 7.9 miles (12.8 kilometers) away. All death certificate and burial permit services were resumed by 4:00 p.m. Telephone and computer communications were disrupted by the attacks; key-entry of death certificate data resumed September 17. However, use of the data for analysis and death certificate retrieval was not possible until October 3, when the system's connection to the mainframe computer in Brooklyn was restored.

The WTC attacks created an unprecedented need to issue thousands of death certificates in the absence of human remains. NY state law (Estates, Powers and Trusts Law §2-1.7) provides for the presumption of death because of absence related to exposure to specific peril. However, no procedure existed to receive, evaluate, adjudicate, file, and issue death certificates at the volume and speed that was required. By September 25, the NYC Law Department, the NY State Office of Court Administration, OCME, and NYCDOHMH had developed and implemented procedures for issuing a death certificate in the absence of human remains. OVR then provided 10 certified death certificates to each family within 24 hours of receipt from the medical examiner, waiving the usual fees.

To prevent fraudulent issuance of birth certificates of decedents, on October 23, NYCDOHMH began mailing copies of death certificates to states of birth and residence through the Interstate Transcript Exchange Program. NYCDOHMH also began sharing fact-of-death information with the regional Social Security Administration office to prevent fraudulent issuance of death benefits, and provided information to the NYC Police Department.

The findings in this report are subject to at least two limitations. First, the data are preliminary because some families have not yet requested death certificates, and investigations into certain requests for certificates are ongoing. Second, demographic information was collected from family members through special affidavits; this information is being revised as corrections are made by family members.

Other vital records agencies might find the emergency death certificate procedures developed by NYCDOHMH to be useful in preparing for and responding to similar disasters (*2*).

States should develop procedures to issue death certificates in the absence of human remains, registration systems that can process both the normal volume of births and deaths and high volumes in emergencies, and systems and operations that can be relocated if power and communications systems fail.

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Notice to Readers

New Classification for Deaths and Injuries Involving Terrorism

Classification of the deaths and injuries that occurred as the result of the events of September 11, 2001, presented CDC's National Center for Health Statistics (NCHS) with a dilemma. Under the current classification systems for mortality and morbidity, the World Health Organization's *International Classification of Diseases, Tenth Revision* (ICD-10) and the United States' *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM), deaths and injuries associated with acts of terrorism could not be identified uniquely.

To evaluate the adequacy of the classification systems for characterizing terrorism-related deaths and injuries and in response to requests from the affected states for guidance in classifying these events, NCHS formed an Ad Hoc Workgroup on the Classification of Death and Injury Resulting from Terrorism. The recommendations of the workgroup and consultations with other federal and nonfederal partners resulted in the development by NCHS of a new set of codes within the framework of ICD-10 and ICD-9-CM and a set of guidelines that will allow the classification of deaths and injuries associated with terrorism (*1*).

For mortality, the codes developed include *U01-*U02 for terrorism involving an assault (homicide) and *U03 for terrorism involving intentional self-harm (suicide) (Table 1). Additional information about the structure of the mortality codes and inclusion terms is available at http://www.cdc.gov/nchs/about/otheract/icd9/appendix1.htm. The asterisk preceding each code indicates that the code was introduced by the United States but is not officially part of the ICD. Codes from the "U" Chapter of ICD-10 were selected because this chapter was reserved specifically for "future additions and changes and for possible interim classifications to solve difficulties arising at the national and international levels between revisions" (*2*). To maintain international comparability in reporting homicide and suicide rates, deaths coded to *U01-*U02 will be included in general tabulations with other homicides (X85-Y09 and Y87.1), and deaths coded to *U03 will be included with other suicides (X60-X84 and Y87.0). Implementation of the codes developed for mortality classification is effective with 2001 mortality data.

TABLE 1. *International Classification of Diseases, Tenth Revision* codes associated with terrorism

X85-Y09, Y87.1, *U01-*U02 Assault (homicide)	
*U01	Terrorism
*U01.0	Terrorism involving explosion of marine weapons
*U01.1	Terrorism involving destruction of aircraft
*U01.2	Terrorism involving other explosions and fragments
*U01.3	Terrorism involving fires, conflagration, and hot substances
*U01.4	Terrorism involving firearms
*U01.5	Terrorism involving nuclear weapons
*U01.6	Terrorism involving biological weapons
*U01.7	Terrorism involving chemical weapons
*U01.8	Terrorism, other specified
*U01.9	Terrorism, unspecified
*U02	Sequelae of terrorism
X60-X84, Y87.0, *U03 Intentional self-harm (suicide)	
*U03	Terrorism
*U03.0	Terrorism involving explosions and fragments
*U03.9	Terrorism by other and unspecified means

For injuries associated with terrorism not resulting in death, the codes developed include E979 and E999.1 (Table 2). E979 was unused previously in ICD-9-CM; E999, which was used previously to denote the late effects of war operations, was modified to include late effects of terrorism. E999.0 was created to classify the late effects of war operations, and E999.1 was created for late effects of terrorism. Additional information about the structure of the morbidity codes and inclusion terms is available at http://www.cdc.gov/nchs/about/otheract/icd9/appendix1.htm. For statistical purposes, codes E979 and E999.1 will be tabulated with other assaults (E960-E969). No plans exist to create a parallel category for self-inflicted

TABLE 2. *International Classification of Diseases, Ninth Revision* codes associated with terrorism

E979	Terrorism
E979.0	Terrorism involving explosion of marine weapons
E979.1	Terrorism involving destruction of aircraft
E979.2	Terrorism involving other explosions and fragments
E979.3	Terrorism involving fires, conflagration, and hot substances
E979.4	Terrorism involving firearms
E979.5	Terrorism involving nuclear weapons
E979.6	Terrorism involving biological weapons
E979.7	Terrorism involving chemical weapons
E979.8	Terrorism involving other means
E979.9	Terrorism, secondary effects
E999	Late effect of injury due to war operations and terrorism
E999.0	Late effect of injury due to war operations
E999.1	Late effect of injury due to terrorism

injury. Implementation of the codes developed for morbidity will be effective October 1, 2002.

For the new terrorism codes to be used for the classification of deaths and injuries, the incident in question must be designated as a terrorist act by the U.S. Federal Bureau of Investigation (FBI), which has jurisdiction over the investigation and tracking of terrorism in the United States. The FBI defines a terrorism-related injury as one resulting from the "…unlawful use of force or violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives" (*3*). This precludes individual judgments made by medical examiners, coroners, medical coders, nosologists, or hospital staff. If the incident is labeled as a terrorist act before the completion of the death certificate or the filing of the medical record, it may be so described on the certificate or discharge record. When the incident is labeled as terrorism after the death certificate has been filed, the certificate can be recoded. Updating and recoding of the medical record after it is completed and submitted for reimbursement is more complicated and is unlikely to occur.

The standardized classification systems described here address the need to identify deaths and injuries resulting from terrorism and will allow a better assessment of the public health impact of terrorism in the United States.

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Notice to Readers

Revision to the *MMWR* Editorial Policy and Publication Schedule in Response to Terrorism and Other Public Health Emergencies

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Reference

1. CDC. CDC Recognition of Members of *MMWR* Distribution Partnership. MMWR 2001;50:1088.

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