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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 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.

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.

References

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2. D Prezant, M Weiden, G Banauch, et al. Cough and bronchial responsiveness in firefighters exposed at the World Trade Center site. *N Engl J Med* 2002(in press).
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Box

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).

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.



Kerry Kelly, 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.



David Prezant, M.D.

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.

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Table

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.

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Figure

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



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