



Implications of the World Trade Center Attack for the Public Health and Health Care Infrastructures

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The September 11, 2001, attack on the World Trade Center had profound effects on the well-being of New York City.

The authors describe and assess the strengths and weaknesses of the city's response to the public health, environmental/occupational health, and mental health dimensions of the attack in the first 6 months after the event. They also examine the impact on the city's health care and social service system.

The authors suggest lessons that can inform the development of a post-September 11th agenda for strengthening urban health infrastructures. (*Am J Public Health*. 2003;93:400–406)

AT 8:46 AM ON SEPTEMBER 11, 2001, as all the world now knows, a Boeing 767 jet flew into the North Tower of the World Trade Center (WTC) in Lower Manhattan. Eighteen minutes later, another plane crashed into the South Tower. Within 2 hours, both towers had collapsed. The crash and the resulting fires and building collapses killed 2801 people, 147 of whom were passengers on the 2 jets.¹ In the following days, millions of people in the metropolitan region were exposed to a combination of air pollution, dangerous work conditions, and psychological trauma. The attack also placed unprecedented demands on New York

City's public health, health care, and social service systems.

This article assesses the strengths and weaknesses of the city's initial response to the attack, describes the short-term impact in the first 6 months after the attack, and suggests lessons that can inform the development of a post-September 11th agenda for strengthening urban health infrastructures. While the focus of this report is on the attack and the initial response, new reports on both short- and longer-term effects are emerging regularly. Where relevant, we refer to published studies and official reports released through September 2002. This report is based on public documents as well as presentations at a March 2002 conference, "The Public Health Aspects of September 11th."

PUBLIC HEALTH SYSTEM

Thirty-two minutes after the first plane crash, the New York City Department of Health (DOH) activated its incident command center. In the first chaotic hours, the city's Office of Emergency Management, located in the WTC, was evacuated; many telephone and computer lines ceased to function; the police closed Lower Manhattan, making it difficult to mobilize the 20% of

the DOH's workforce located there; and emergency medical staff and civilians unexpectedly brought injured people into the DOH lobby, necessitating the deployment of a crisis medical team.²

Fortunately, the DOH had an emergency response infrastructure in place, developed in accordance with established public health principles and incorporating several key elements—for example, an incident command system; laboratory, surveillance/epidemiology, medical, and environmental response capability; and communication mechanisms and training exercises.^{3,4} From the start, these plans and previously rehearsed exercises helped to organize the work and set priorities.² By the afternoon of the first day, the DOH had joined with the American Red Cross to staff 10 emergency shelters, transported medical supplies from other DOH facilities to Lower Manhattan, and moved to a safe location the office that approved permits for burials. By the second day, the DOH had moved its own central office staff, reestablished critical Management Information Systems functions, and implemented a plan to communicate with staff, press, and health care providers.²

In the days after the attack, the DOH focused on surveil-

lance, maintenance of routine functions, and communications. It established 4 surveillance systems: a rapid assessment of injuries related to the attack; a hospital needs assessment; a reporting system of injuries among rescue and recovery workers; and a syndromic surveillance system for monitoring symptoms associated with biological or other agents, staffed by 15 Centers for Disease Control and Prevention (CDC) epidemic intelligence officers assigned to hospital emergency rooms. Ultimately, an electronic reporting system was established at 30 local hospitals.²

An equal priority was to maintain routine DOH functions. For example, DOH staff monitored food and drinking water served to emergency workers at Ground Zero (the WTC site) to ensure that it was safe; checked conditions at the city's wholesale fish market, relocated because of the disaster; and, to prevent outbreaks of rodents, cleaned up food in abandoned restaurants.²

Communications was a third priority. The DOH broadcast faxes to area hospitals with alerts and the results of surveillance, held press conferences on air quality, and prepared information packets on recommendations for cleanup and reoccupancy of buildings.²



ENVIRONMENTAL AND OCCUPATIONAL HEALTH

The WTC attacks have been characterized as “an unprecedented environmental assault for lower Manhattan.”⁵ They exposed various populations to contaminants in 3 phases: from the plume created by the initial fire and building collapses; from ongoing fires, lasting at least 3 months; and from the resuspension of particles during the cleanup and transport of debris at Ground Zero and surrounding sites. An estimated 1.2 million tons of building material, representing 15 million to 20 million square feet of office space, was destroyed or severely damaged.⁶ While building materials are not normally immediately hazardous, the intense heat and fire, propelled by 180 000 gallons of fuel,⁷ caused their rapid volatilization and the release of combustion byproducts. The mechanical energy of the collapse caused their pulverization and dispersion into the environment.

Although the precise materials at the WTC site are unknown, up to 2000 tons of asbestos was used in its construction.⁸ Fiberglass was used for insulation and Freon in air conditioning systems. The WTC also contained several large fuel tanks. Other toxic materials were present in office equipment and fixtures, including lead, mercury, and polyvinyl chloride. In addition, plastic furnishings were treated with coatings that can produce dioxins and volatile organic compounds. Overexposure to combustion byproducts among firefighters has been well

TABLE 1—Examples of Organizations Involved in the Public Health/Health Care Response to the World Trade Towers Attacks

Organization	Public Health	Environmental/ Occupational Health	Mental Health	Health Services
New York City agencies				
Department of Design and Construction		X		
Department of Environmental Protection		X		
Department of Health	X	X	X	X
Department of Mental Health, Mental Retardation and Alcoholism Services			X	
Fire Department		X		
Health and Hospitals Corporation			X	X
Office of Emergency Management		X		
New York State agencies				
Department of Environmental Conservation		X		
Department of Health	X	X		X
Office of Mental Health			X	
Port Authority of New York and New Jersey		X		
Federal agencies				
Agency for Toxic Substances and Disease Registry		X		
Centers for Disease Control and Prevention	X	X		
Emergency Management Agency		X	X	X
Environmental Protection Agency		X		
Geological Survey		X		
National Institute for Environmental Health Services		X		
National Institute for Occupational Safety and Health		X		
Occupational Safety and Health Administration		X		
Private social service agencies (United Way, Salvation Army)			X	
Private mental health agencies (e.g., Coalition for Voluntary Mental Health Organizations)			X	
Private health care organizations (American Red Cross, Greater New York Hospital Association)			X	X
Private academic institutions (Columbia University, New York University)		X		X
Private consulting organizations		X		

documented in the literature.^{9,10} As shown in Table 1, at least 15 federal, state, and city government offices and agencies as well as several academic, medical, and other organizations responded to various WTC-related environmental issues.^{2,5,11}

Risk assessment (i.e., characterizing the extent of contamination

and estimating the impact on human health) has been a critical and controversial component of the environmental response. Several factors limit our knowledge: monitoring equipment to measure possible contaminants was understandably not in place on September 11th,¹² the dispersion of contaminants was not uniform,¹³ the

continuing fires made the environment highly unstable, and experts do not agree about appropriate sampling methodology and evaluation criteria.¹⁴ While results of environmental sampling for specific substances at specific locations have been made available, to date, no organization has publicly released a comprehen-



sive synthesis and review of available environmental data or conducted a human health risk assessment to characterize the nature and extent of exposure, or the short- or long-term health effects. Finally, some critics allege that the intense pressure to restore New York's financial center may have led the government to minimize environmental risks and to provide recovery and cleanup workers and building occupants with inadequate information and protection.^{7,15}

Still, tens of thousands of indoor and outdoor air and dust, leachate, and water samples were collected in the months following the attack and analyzed for more than 70 contaminants, including asbestos, lead, chromium, mercury, and other metals; polychlorinated biphenyls (PCBs); dioxins; and several other organic compounds.^{16,17} Early sampling of dust and debris near the WTC site found the primary contents to be pulverized glass, gypsum, concrete, and paper, with small amounts of asbestos. This highly alkaline material, which can cause upper respiratory irritation, contained high concentrations of sulfate, calcium carbonate, and bicarbonate, as well as several metals.^{13,18} Most outdoor air contaminant levels have been lower than existing limits. Overall, these levels have been highest at Ground Zero and have dissipated with time and distance from the site.¹⁷ Less comprehensive information is available about indoor air and dust in nearby buildings. According to one government survey, detectable levels of asbestos and fibrous glass were found in

20% and 42% of dust samples, respectively, but not in air.¹⁹

Several months after the attacks, most government agencies and environmental professionals agreed that outdoor air quality in Lower Manhattan was similar to that of other parts of the city. Still, there is continued concern about "hot spots" and whether nearby building facades and indoor spaces (e.g., schools, residences, and commercial establishments) have been properly cleaned.^{5,20,21}

The available evidence suggests that the most heavily exposed people were recovery workers, including emergency responders and construction workers at Ground Zero. In addition to chemical exposures, they faced significant safety hazards from working in an unstable physical environment, as well as psychological trauma from losing coworkers and viewing and handling human remains. Fortunately, during the first 6 months of the recovery effort, there was not a single fatality, and injury rates were below national averages.¹⁶ Of 10 116 New York Fire Department rescue workers evaluated, approximately 90% reported respiratory ailments,²² with 1 in 4 unable to return to work as of December 2001,²³ and by September 2002, over 574 were still on medical leave with respiratory disability or emotional stress.²² Many construction workers were also affected with acute upper airway inflammation, especially those with preexisting asthma, and some suffered acute injuries. Symptoms persisted for some at least 5 months after the cessation of exposure.²⁴

Outside of Ground Zero, thousands of building cleanup workers were exposed to dust particles. In medical evaluations of 415 workers (mostly non-English speaking, nonunionized, temporary workers), conducted in a mobile van located near the former WTC, major symptoms were found to be upper airway irritation and other nonspecific symptoms including insomnia, headaches, and dizziness. None had health insurance or access to regular medical care.²⁵ Employees of a nearby college had elevated rates of these symptoms, which persisted 6 months after the attacks.²⁶

Nearby residents were also affected. Six weeks after September 11th, the DOH conducted a survey of 414 Lower Manhattan residents and found that about half were experiencing symptoms.²⁷ More rigorous studies (e.g., of pregnant women, schoolchildren, construction workers) are under way, but the results will not be available for some time.²⁸

MENTAL HEALTH

By definition, terrorism is an assault on the mental health and well-being of the public. Its goals are to create panic, fear, and anxiety. The attacks on the WTC affected the mental health of New Yorkers in 3 ways: it created psychological distress for millions, exacerbated or precipitated mental disorders among some smaller groups, and threatened social cohesion, one of the foundations for mental health, in a variety of ways.²⁹

The city agency that led the mental health response was the

New York City Department of Mental Health, Mental Retardation and Alcoholism Services (DMH), which was joined by other agencies, as shown in Table 1. Within a few days of the attack, the DMH identified 3 priorities. First, it provided crisis intervention to bereaved families, survivors, workers at Ground Zero, and the general public. LifeNet, a mental health hotline sponsored by the DMH, provided telephone counseling in 5 languages; the average number of calls to the hotline doubled in the days after the attack. Family Assistance Centers were established to provide counseling and to assist people in searching hospitals for loved ones, filing death certificates, and collecting DNA samples.³⁰

Second, the agency worked with other providers to develop a long-range plan to provide mental health services to those affected by the attack. A consortium of agencies created Project Liberty; by March 2002, this project had located new support services at 68 agencies and 120 sites.^{30,31} A third priority was to maintain the public mental health system in which the DMH funded more than 1000 agencies to care for almost 300 000 people with mental illness or disability.³⁰

The attack affected the mental health of millions of New Yorkers in the following months.³² An assessment of residents of Lower Manhattan²⁷ in October found that 40% reported symptoms suggestive of posttraumatic stress disorder. Less than a third of respondents had received supportive counseling, and many resi-



dents were unaware of or did not have access to mental health services.²⁷

A telephone survey of 1008 adults from a random sample of households in Lower Manhattan in October and November 2001 found that 7.5% reported WTC-related symptoms of post-traumatic stress disorder and 9.7% reported symptoms of current depression.³³ Symptoms were more severe for those closer to the site and those who had lost property or relatives. Subsequent studies show that while the prevalence of symptoms declined over time, at least some symptoms persisted more than 3 months after the attack,³⁴ and that vulnerable populations such as drug users experienced unique effects.^{35–37}

No systematic data are available yet on the impact of the attack on social cohesion or division, but newspaper accounts suggest that assaults on Arab Americans increased after September 11th.³⁸

HEALTH CARE AND SOCIAL SERVICES

Within minutes of the attack, hospitals in Lower Manhattan prepared to receive victims. Within hours of the attack, thousands of people began to congregate in local hospitals, looking for family members or friends, seeking safety, or offering to volunteer; hospitals were thus forced to develop crowd management strategies.

The Greater New York Hospital Association (GNYHA), the trade group for the health care industry, played a key role in re-

sponding.³⁹ On September 11th, GNYHA worked closely with emergency service and health officials to make information about bed availability readily available. GNYHA also established a patient locator service to help people find family members.

A CDC survey of 4 local hospitals and the regional burn referral center found that in the 48 hours after the attack, 1688 patients received care at these hospitals, of whom 65% were WTC survivors treated for injuries or illness, mostly inhalation or eyes injuries, related to the attack.⁴⁰ In late September, a GNYHA telephone survey of its members found that 91 metropolitan area hospitals had provided emergency room treatment to about 6000 WTC victims and admitted 500.⁴¹

In the following weeks, the disaster affected hospital finances. Hospital admissions declined, leading to lost revenues, and the proportion of uninsured patients increased.⁴² Health care funding streams changed as well. To assist victims of the disaster and to minimize disruption due to lost government functions, New York State established Disaster Relief Medicaid, designed to provide 4 months of Medicaid benefits to eligible low-income New Yorkers. By January 31, 2002, almost 400 000 New York City residents enrolled in this program. After completing a 1-page form attesting to their income, applicants were given Medicaid coverage, usually on the same day—a dramatic reduction in the time usually required to determine eligibility. In early 2002, New York

State authorized automatic recertification of Medicaid beneficiaries in New York State through September 2002.⁴³

While the impact on smaller community-based health and social service providers has not been studied systematically, testimony by providers at several public meetings held in New York City in the 6 months following the attack suggested the following: higher levels of stress among staff and clients, disruptions in client entitlements such as Medicaid and welfare due to some government offices being shut down, disruption in agency funding, and cutbacks in public funding due to budget deficits in New York City and New York State. Providers in these agencies reported that their ability to provide safety net services to their clients was compromised by these factors.

IMPLICATIONS FOR PUBLIC HEALTH AND HEALTH CARE

In the aftermath of September 11th, public and nonprofit organizations, health providers, and ordinary citizens responded with courage and professionalism. Their actions saved lives, helped New Yorkers to cope with fear and grief, and helped the city to restore key functions.

The health and systemic sequelae of September 11th also revealed several shortcomings in the city's public health and health care infrastructures. They are summarized here, not to criticize any specific agency or individual but to guide future action.

First, the structure of government hampered its response to the crisis. The events of September 11th highlighted gaps in the environmental regulatory framework (e.g., outdated or inadequate standards for nonindustrial indoor air quality) and ambiguity about which of the 3 levels of government was responsible for what. Even where regulations existed (regarding asbestos, for example), none had been construed with a WTC scenario in mind, and controversy thus arose over jurisdiction and applicability. In some instances, this led to long delays in clear criteria regarding guidance, action, and clearance (e.g., residential cleanup), which were only addressed months after the attack.²¹ The lead agency for specific issues was not always identified in advance. While the city's mayor assumed leadership on public safety, no single agency claimed responsibility for health or the environment. Moreover, no prior mechanism existed for resolving conflicts—especially in the early days—between, for example, law enforcement and public health agendas (e.g., who had access to the Ground Zero “crime scene”).

Second, although agencies reported that disaster exercises had helped them to respond more effectively, the attacks illuminated gaps in emergency planning and disaster preparedness. The scope of the attack was unanticipated. The destruction of the city's crisis center and the necessity of integrating responses across many sectors posed formidable challenges, such as surveillance and communication, especially in the



hours after the attack. No plan, however, can anticipate all possibilities, demonstrating the importance of maintaining a robust infrastructure that has reserve capacities beyond routine functioning. In the decade prior to September 11th, New York City had lost 10% of its public workforce in health and social services,⁴⁴ reducing its reserve capacity for emergencies.

Third, the events emphasized the importance of strengthening surveillance systems for environmental and health conditions, and they have led to post hoc efforts to identify, screen,⁴⁵ and track affected persons.⁴⁶ This may serve as a model for the establishment of registries for rescue and cleanup workers at a disaster, and it will assist in documenting adverse outcomes and linking people to services. The attack also demonstrated the importance of mental health surveillance in order to guide development of appropriate and timely services and prevention education.

Fourth, communications emerged as a critical issue. Public health authorities had to communicate with other government agencies, with health care providers, and with the public. Communications needs changed over time. The disaster highlighted the necessity of redundant communication systems—not only multiple locations but also multiple forms of communication (cellular and regular telephones, radio, fax, Internet).

While many agencies quickly set up ways to transmit information to the public, they had more trouble listening to community

concerns. The gap between government assurances of environmental safety and public experience of persistent symptoms (such as “WTC cough”) could have been minimized if emergency task forces and planning groups had included medical and scientific experts and community representatives, and if surveys elicited concerns as well as symptoms. Early 2-way communication can help to reduce distrust and maintain credibility.

Fifth, the attacks emphasized the importance of linking the public health system to health and mental health services. In the last few decades, New York City, like other jurisdictions, has separated public health and health care systems. When surveillance systems identified health problems, it was sometimes difficult to link people to the services they needed—for example, the occupational problems of immigrant cleanup workers or the mental health problems of uninsured Lower Manhattan residents. Disaster Relief Medicaid was a creative partial response to this problem and demonstrated that government can cut red tape to meet emergent needs. In the longer run, the lack of a national health plan and the limitations of current mental health parity laws compromise the ability to respond to either disasters or routine health needs.

Sixth, the response to the WTC attack suggested new approaches to the education and training of public health professionals and toward public health research. Recently, the CDC and other federal agencies have expanded training for a public health response to terrorism.

⁴⁰ The attack highlighted additional competencies that will be needed, including the ability to communicate confidently and effectively with other systems (law enforcement, economic development, and construction), to elicit public perceptions and attitudes, and to integrate physical and mental health surveillance, emergency response, and services.

On the research side, public agencies and researchers have generally collaborated well to identify specific problems and devise solutions. Once again, however, the lack of coordination and leadership has made it difficult to select priorities or to ensure common instruments that will allow researchers to share data or compare findings. One exception is an effort by officials and investigators at the New York State Department of Mental Health and Columbia University to develop a unified research agenda.³² Too often, however, the competitive and anarchic character of the New York City research community and its weak links with municipal agencies⁴⁷ have meant that dozens of investigators are conducting WTC-related research largely without coordination.

Finally, the response to September 11th demonstrated the importance of finding a balance between responding to crisis and maintaining other vital public health functions. Even before the WTC attack, 3 million New York City residents lacked health insurance, the unemployment rate had increased by more than 25% in the prior 2 months, welfare policies had added 350 000 mostly unskilled adults to the local labor

market, and city and state governments faced daunting budget deficits.⁴⁸ Responsible public health officials had to balance addressing these problems with the response to the attack. While the city stood to gain millions of federal dollars for strengthening its public health capacity to respond to terrorism, some public health experts feared that these new resources were too narrowly targeted.⁴⁹ Not only would the new dollars fail to rebuild the broader public health infrastructure, which had been underfunded for years, but they would also fail to increase health and mental health coverage for the city’s most vulnerable populations.⁵⁰

One of the most striking lessons from the WTC attack was the extent to which it demanded routine health functions: safeguarding air quality, protecting workers, ensuring food safety, controlling pests, funding and providing the physical and mental health services that relieve acute distress, and offering credible health information. While the WTC attack has left indelible marks on the well-being of New York, its most powerful lesson for the health community may be how much the city depends on functioning public health and health care systems. ■

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This article was accepted November 10, 2002.

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Both authors conceptualized the framework for the article and cowrote the introduction and the section on implications for the public health and health care infrastructures. S. Klitzman researched and wrote the section on environmental and occupational health. N. Freudenberg researched and wrote the introduction and the section on health care and social services.

Acknowledgments

We are indebted to the following people for their presentations at the March 14, 2002, conference on "The Public Health Impact of September 11th," held at Hunter College and supported by the City University of New York: Bonnie Bellow, US Environmental Protection Agency; David S. Chen, Chinese-American Planning Council; Patricia K. Clark, US Occupational Safety and Health Administration; Heike Thiel de Bocanegra, Safe Horizon; Sandro Galea and David Vlahov, New York Academy of Medicine; Eric Goldstein, Natural Resources Defense Council; Jeffrey Grabelsky, Cornell University; Christina Hoven, Columbia University; Stephen Levin, Mount Sinai Medical Center; Steven Markowitz, Queens College, CUNY; Jackie Merrill, Columbia University; April Naturale, New York State Office of Mental Health; David Newman, New York Committee for Occupational Safety and Health; Jane Plapinger, New York City Department of Mental Health, Mental Retardation and Alcoholism Services; Christine C. Quinn, New York City council member; David Rosner, Columbia University; Victor Sidel, Montefiore Medical Center, Albert Einstein College of Medicine; Denise Soffel, Community Service Society of New York; Ezra Susser, Columbia University; George D. Thurston, New York University; Doris Varlese, Greater New York Hospital Association; Issac B. Weisfuse, New York City Department of Health. This article is based on their observations as well as our review of media coverage and available published and on-line reports on the health impact of the September 11th events. These individuals, along with the thousands of staff in their organizations, have continued to work tirelessly to pro-

tect the health of New Yorkers during and after the WTC attacks, and we acknowledge their extraordinary efforts. We also thank Salwa Nassar for assistance in preparation of the manuscript and 2 anonymous reviewers for their helpful suggestions.

Note. The opinions expressed in this article represent the point of view of the authors and not necessarily the organizations sponsoring The Public Health Impact of September 11th conference or the speakers.

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