The aftermath of the World Trade Center collapse

O n 11 September 2001 life changed for many people in the New York Metropolitan Area, in the United States, and in many parts of the world. Many have speculated that some of these changes in commerce, travel, and in a sense of personal security, will be enduring. For occupational and environmental health (OEH) professionals it is likely that there will be some enduring changes in the focus of their practice. We examine some aspects of the aftermath of the World Trade Center collapse from an occupational and environmental medicine (OEM) viewpoint and speculate on how this could impact OEM.

New York’s vaunted plan for handling mass casualties was tragically never tested, as the number of injured survivors was limited to approximately 600, with a still inexact number killed (3000–4000), including 343 firemen. From the health and safety perspective we see four target populations (building occupants, rescue workers, demolition workers, and neighbouring residents) and three phases: immediate evacuation (hours), rescue and recovery (about 10 days), and demolition and removal (months), followed by a potential for persistent effects.

For workers and bystanders in phase I there were traumatic injuries, including acute smoke and fume inhalations which could ultimately give rise to well known syndromes such as reactive airways dysfunction syndrome (RADS). A listing of subsequent first aid and emergency medical cases shows that among the injuries in the first three weeks were chest pain, contusions, lacerations, burns, and various lung injuries, although information on severity is not available at this time. Remarkably no deaths have been reported among rescue workers despite the hazardous spelunking below the mangled pile.

The 10 acre site included seven buildings, with each tower footprint about 209 feet square (1 acre). Estimates place the number of occupants and visitors at at least 50 000 per day. Electric power was shut down for hundreds of thousands of commercial and residential customers for approximately two weeks. There were huge job losses, and residents of nearby buildings were first denied access, and then allowed to return to devastated and contaminated buildings, although re-entry precautions did not reach people uniformly. From our vantage point of two months after the collapse, it seems that it will be more chronic and subtle OEM issues, rather than traumatic and devastating injuries, which will challenge OEM professionals.

“Health and safety of recovery workers was a prime concern”

A primary issue is the health and safety of the rescue, recovery, and demolition workers on the massive site. By one week after the collapse there were 10 000 individuals working for four major contractors and various government agencies, but no comprehensive site safety plan. There were warehouses full of safety equipment, but no clear plan and enforcement for how and when it would be used. During phase II, exposures were uncertain, respirator use remained haphazard, and respirator training and clearance were phased in. Air monitoring and surface sampling were conducted by several agencies, but it was days to weeks before attempts were made to produce a comprehensive database available to the public and to responders. Overflow of runoff water from the fire suppression activity into the nearby Hudson River, contained a number of toxins, but preliminary estimates are that this was substantially diluted.

Asbestos emerged as a primary toxic concern for both site workers and neighbours. Asbestos also gives an example of the need for agencies to coordinate sampling and information. Asbestos fire-proofing was used in the early stages of construction and was then replaced by other materials about halfway through. Asbestos fibre contamination was widespread after the collapse, but different agencies sampled using different methods, reported results in different units, and compared results to different standards. Some, adhering to federal guidelines, reported that since most fibres were shorter than 5 μm there was minimal risk. However, the literature does not convincingly support this position, and shorter fibres can be neither clearly implicated nor exonerated. Others reported that some asbestos samples exceeded one or another “standard” there was a serious risk, without clarifying that the standards are based on 40 years (worker exposures) or 70 years (household/community exposures). Others claimed erroneously that since the asbestos was chrysotile, risk could be ignored. Information consumers were left with substantial uncertainty.

Prior to the availability of adequate air sampling data, the use of respiratory protection was recommended. But the availability of respirators, the fit testing, training, and medical screening of workers required by the OSHA Standard (1910.134) could not be immediately implemented.

There were few known hazardous chemicals stored in bulk on the site. Within the week preceding the attack, 160 000 pounds of a fluorocarbon refrigerant had been delivered, and was in a basement beneath the rubble. While fluorocarbons are mainly hazardous as confined space asphyxiants, there was concern that the ongoing fire could convert this material to phosgene. Managing such a relatively remote concern in the setting of ongoing attempts at life saving rescue by descent of emergency personnel into the rubble pile, gave rise to difficult risk management scenarios, again across agencies and stakeholders.

“Dust was a major problem”

Within two weeks the 9000 residents of nearby buildings were allowed to return to their apartments. The initial collapse was characterised by production of a massive amount of dust from crushed concrete, asbestos, and other insulation materials, furnishings, paints, office, and janitorial supplies. Dust covered surrounding streets, and rescue workers who had responded before the collapse reported being engulfed in overwhelmingly thick clouds, which also penetrated hundreds of local buildings, both through broken windows and through infiltration of ventilation systems. The fact that some of this dust contained significant amounts of condensed lead fume (from paint) and

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**Abbreviations:** OEH, occupational and environmental health; OEM, occupational and environmental medicine; PTSD, post-traumatic stress disorder; RADS, reactive Airways Dysfunction Syndrome; WTC, World Trade Center

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asbestos fibre, has already led to concern as individuals moved back into their homes. There was a lack of clear guidance on the type of clean-up (for example, wet mopping, HEPA vacuuming) necessary. This was further complicated by the inadequate supply of reputable, trained, clean-up professionals, and has caused heartache for affected families, who have had a hard time competing with the many businesses for this limited assistance. Additional concerns have included the toxic products of combustion, discussed below, which may be present in the dust. Risk communication continues to evolve slowly with the pain-full conflicted missions of providing education on exposure reduction as well as reassurance based on evolving data. Many health concerns are associated with the ongoing exposure to smoke and fumes. During phase II, winds carried the smoke plume, or invisible odours alternately to Brooklyn and New Jersey. In phase III, the intensity of the smoke declined, but local eddying winds continue to cause rapid shifts in the location of odours from the still smouldering site. Odours described as "burning", "plastic", "foul", or "piercing" have become a bane for local residents and businesses. Newspaper accounts identified various volatile substances such as benzene and styrene in air samples, with raised concentrations even in November. Associated complaints include headache, mucous membrane symptoms, and burning throats, and seem directly associated with the odour, rather than the sometimes more vague and unexplained symptoms of typical sick building problems.

“Chronic respiratory problems may develop”

Based on the above exposures, a number of health concerns are beginning to become evident for those involved in the clean up or those living and working in the immediate environment of the collapse. The risk for chronic respiratory effects is paramount in many health care and site workers’ minds. The reported widespread development of a “cough”, dubbed “WTC cough” by the firefighters who seem most prominently affected, has heightened this concern. It should be noted that virtually all 11 000 New York City firemen have been at the site for extended periods of time. In addition to various examinations of samples of site workers conducted by the National Institute for Occupational Safety and Health (NIOSH) and some unions, the Fire Department of the City of New York (FDNY) is undertaking examinations of all of its members in an attempt to physiologically categorize and explain the cough and other respiratory symptoms. Based on the literature, the likelihood that single or multiple exposures to dust or smoke, after the first few days, has a high likelihood of causing persistent irritant asthma (RADs) is low, although exacerbation effects may be expected. Data from this group with dioxin exposure; epidemics of psychiatric illness, specifically post-traumatic stress disorder (PTSD); for example, war, Oklahoma City Bombing); or epidemics of symptoms not adequately explained by standard diagnosis. We know that some combination of these unexplained symptomatic health effects occurred in about 15% of US and UK soldiers deployed to the Gulf, and that to date, in spite of limited toxic associations with these symptoms, psychosocial factors remain the only treatable or well documented correlates of the problem. Such a syndrome is also well described for residents near waste sites, in which smelling odours synergised with concern for the environment to be associated with numbers of symptoms reported.

Treatment and preventive approaches for PTSD have been mobilised for both site workers and others affected. Studies are underway, for both emergency responders and for the general public, to examine the nature and the correlates of symptoms beyond the expected acute stress reactions and PTSD. These can be compared and contrasted with extensive data on Gulf War veterans and others, who have been studied in terms of symptoms and beliefs, but with only limited quantitative information on exposures. Additional studies should examine how employer medical, employee assistance programmes, and human resource responses can assist or reduce trauma impacts.

We believe that the explicit incorporation of psychosocial trauma, vulnerability, and responses with toxic exposures and risk assessment, as well as risk communication about them, represents a complex emerging new OEM agenda. Scenarios such as the irritating and odiferous stov of the smoky WTC plume, or merely inadequate indoor ventilation, seem to be more and more in our future. Taking this bull by the horns, and planning ahead for psychosocial–organic interactions, especially in cases with measurable toxic exposures, will help prepare OEM for the questions and challenges which lay ahead.

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