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Natural Disasters and Nontuberculous Mycobacteria
A Recipe for Increased Disease?

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Infectious diseases acquired by survivors of large-scale natural disasters complicate the recovery process. During events such as tsunamis, hurricanes, earthquakes, and tornados and well into the recovery period, victims often are exposed to water-soil mixtures that have relocated with indigenous microbes. Because nontuberculous mycobacteria (NTM) are ubiquitous in water and soil, there is potential for increased exposure to these organisms during natural disasters. In this hypothesis-driven commentary, we discuss the rise in NTM lung disease and natural disasters and examine the geographic overlap of NTM infections and disaster frequencies in the United States. Moreover, we show an increased number of positive NTM cultures from Louisiana residents in the years following three of the relatively recent epic hurricanes and posit that such natural disasters may help to drive the increased number of NTM infections. Finally, we advocate for increased environmental studies and surveillance of NTM infections before and after natural disasters. CHEST 2015; 147(2):304-308

ABBREVIATIONS: NTM = nontuberculous mycobacteria

> Climate change is disrupting natural ecosystems in a way that is making life better for infectious diseases.
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Large-scale natural disasters may be classified as hydrometeorologic (floods, typhoons, hurricanes, tornados), geomorphologic (landslides, avalanches), or geophysical (earthquakes, tsunamis, volcanic eruptions).[1] Disasters in the current century include the Bam earthquake in Iran (2003), Indonesian-Thailand tsunami (2004), and Hurricanes Rita, Katrina, and Ike in the Gulf Coast region of the United States (2005, 2008). An important public health issue is the occurrence of infectious diseases following natural disasters. Natural disasters can cause the aerosolization of high concentrations of environmental particulate matter that likely contribute to respiratory health problems, including infectious lung disease, among survivors.[2] Diverse geographic locations have experienced a rise in pulmonary infections caused by nontuberculous mycobacteria (NTM).[3] Because NTM are ubiquitous in water and soil, we hypothesize that during and after natural disasters, the disrupted ecosystems

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harboring pathogenic environmental NTM species will intersect with human lives, providing greater opportunities for the development of NTM infections and disease.

Natural Disaster-Associated Infectious Diseases

Most infections following natural disasters typically develop from indigenous microbes; that is, infections are rarely the result of imported microorganisms.[4] Infections that develop 24 to 48 h after natural disasters are usually opportunistic, acquired as a direct result of trauma.[5] Infections that arise 1 to 4 weeks after the event are mostly due to food-, water-, and airborne transmissions. Acute respiratory infections are also frequent, especially in conditions where overcrowding develops. For example, > 14% of the population affected by the Bam earthquake experienced respiratory infections, and 12 weeks after the 2004 Indonesian tsunami, 62% of survivors manifested respiratory infections.[6,7]

Global Rise in Natural Disasters

Numerous geological studies, cost reports, and insurance-based studies indicate that natural disaster events are on the rise globally.[8-10] Three times as many natural disasters occurred from 2000 to 2009 compared with the period from 1980 to 1989.[11] In more recent years, the National Oceanic and Atmospheric Administration also reported increases in billion-dollar weather disasters across the United States.[12]

Global Rise in NTM Lung Disease

The incidence and prevalence of pulmonary NTM disease are increasing globally. In Ontario, Canada, Marras et al[13] reported that the 5-year prevalence of NTM lung disease increased from 29.3 cases per 100,000 in 1998 to 2002 to 41.3 per 100,000 in 2006 to 2010. In Queensland, Australia, Thomson[14] reported a rise in the incidence of NTM lung disease from 2.2 cases per 100,000 in 1999 to 3.3 per 100,000 in 2005. Lai et al[15] also reported a rise in NTM lung disease in Taiwan, with an incidence of 1.3 cases per 100,000 in 2000 and 7.9 per 100,000 in 2008.

As for the United States, a 1958 study indicated high exposure to NTM in the southeastern and Gulf Coast regions. Specifically, Edwards et al[16] reported that 33% of 275,558 Navy recruits examined from these regions showed the highest positive skin tests to purified protein derivative-B, a mixture of antigens from the Battey bacillus now known as *Mycobacterium intracellulare*. More recently, Winthrop et al[17] reported disease prevalence in Oregon between 2005 and 2006 to be 8.6 cases per 100,000. Other analyses conducted in Oregon showed the annualized period prevalence rate of NTM pulmonary disease to be 5.6 cases per 100,000 and 15.5 cases per 100,000 in people aged > 50 years.[18] Adjemian et al[19] reported that between 1997 and 2007, the annual prevalence of NTM lung disease significantly increased from 20 to 47 cases per 100,000 in individuals aged > 65 years. Among the states surveyed, Hawaii showed the highest prevalence at 396 cases per 100,000 followed by states in or near the southeast section of the country (eg, Florida, Louisiana, Oklahoma).[19,20] Other states with high rates of NTM infections include California, New York, Wisconsin, Pennsylvania, and Texas.[21] The increased prevalence appears to be more than just increased detection because a study of skin test positivity to purified protein derivative-B in two National Health and Nutrition Examination Survey cohorts showed that sensitization to *M intracellulare* significantly increased from 11.2% from 1971 to 1972 (approximately 1,500 subjects) to 16.6% from 1999 to 2000 (approximately 7,400 subjects).[22] Given that natural disasters can disrupt ecosystems and cause widespread water-soil aerosolization, it is plausible that large-scale natural disasters contribute to the rise in NTM infections.

Current Knowledge of Natural Disaster-Associated NTM Infections

NTM have been recovered from aerosols generated by rivers, dust formed by airflow across rivers, and agricultural fields.[23,24] During certain natural disasters, there is large-scale mixing of ocean water with fresh water as well as water with soil that likely results in aerosolized NTM and an increased number of NTM in potable and nonpotable water, which may then be inadvertently inhaled and aspirated by survivors. Natural disasters may also displace free-living amoebae from various water niches. Because free-living amoebae can provide an intracellular niche for the NTM to multiply and perhaps become more virulent, development of new microbial symbiosis following natural disasters could potentiate NTM survival and proliferation.[25-27] Thus, natural disaster survivors may be at increased risk for NTM lung infections resulting from inhalation or aspiration of contaminated water, soil, or NTM-infected amoebae.[7]

Hoefsloot et al[28] found that human respiratory samples from various countries on several continents show diverse species of NTM, with *Mycobacterium avium* complex being the most frequently recovered, yet there are few published reports of NTM infections