

Natural disasters, corpses and the risk of infectious diseases

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The recent occurrence of the category 4 Hurricane Katrina devastated the United States' Gulf Coast. The hurricane caused widespread destruction and flooding, and left hundreds of thousands of people homeless. The mounting death toll was reported at almost 300 deaths as of September 8, 2005 (1,2). The unfolding events and high death toll have left an unusual situation in which there are many decomposing corpses either lying on the streets or floating in the flood waters. The presence of these corpses in open settings, such as in public places and in the water that has inundated much of the city of New Orleans, naturally raises concerns about the occurrence of infectious disease epidemics (3). In the aftermath of large natural disasters, instinctive uncertainties arise among workers and the general population with respect to the appropriate handling and disposal of dead bodies and human remains. Given the recent occurrence of Hurricane Katrina as a large natural disaster and the unprecedented setting of the numerous corpses requiring disposal, it was considered timely to review the infectious disease risks associated with the handling of dead bodies.

The risk categorization may be examined from the perspective of the classical host-pathogen paradigm, which involves having a pathogen capable of causing invasive infection, a route of transmission and a susceptible host. Although the human body is a natural home to hundreds of species of microorganisms, the organisms involved in putrefaction (mostly anaerobic flora) are not usually considered pathogenic without a large inoculum and exposure occurrence. There are many pathogens that may be associated with human cadavers and these pathogens reflect the organisms that may be transmitted from living humans (4). With the death of a host comes the loss of the living environment for these microorganisms; ultimately, without a host, these organisms cannot sustain their growth. The time after which these once-pathogenic organisms would no longer be considered transmissible, due to their diminution or ultimate demise, depends on the host and other factors, and may be measured in hours or days (4). Organisms traditionally associated with transmission from cadavers include bloodborne viruses (HIV, hepatitis B, hepatitis C, human T-lymphotropic virus 1), enteric bacteria (*Salmonella*,

Shigella, *Campylobacter*, *Yersinia*, *Vibrio cholerae*, *Vibrio vulnificus*, *Escherichia coli*, *Leptospira*), viruses (rotavirus, norovirus, hepatitis A virus and enteric adenovirus), parasites (*Giardia*, *Cryptosporidium*) and airborne agents (*Mycobacterium tuberculosis*) (5). Although there is a risk of carriage among disaster victims, this risk is no greater than the risk of carriage in the general population. Most of the deaths in a natural disaster are due to trauma, drowning or fire, and there is no opportunity for any amplification of the pathogens that the victims may have been harbouring. Severe diseases, such as cholera or typhoid, do not typically break out after hurricanes and floods in areas where such diseases do not naturally occur (5).

A risk of gastroenteritis may be present for the general public if corpses have contaminated the water supply (6). This risk usually occurs in the later phases of a natural disaster. A study (7) in the municipal area of Villanueva, Nicaragua, which was hit by Hurricane Mitch, was conducted in a three-month period following the disaster. The study found that the incidence of acute diarrhea and acute respiratory disease significantly increased following the disaster compared with predisaster data. The incidence of acute diarrhea increased from 2849 to 6798 per 100,000 inhabitants after the disaster ($P < 0.01$), while the incidence of acute respiratory disease increased from 295 to 1205 per 100,000 inhabitants ($P < 0.01$). In addition, three cases of leptospirosis were ascertained, but no predisaster data were available for comparison (7). A cluster of hepatitis A infections occurred in Aceh Province, Indonesia, in the month following the tsunami that struck on December 26, 2004, but it was thought that the water-borne nature of hepatitis A and other water-borne diseases that occurred were caused by a lack of safe water and sanitation and spread by overcrowding rather than through the presence of corpses (8,9).

Emergency and disaster relief workers who directly handle corpses are most at risk for transmission of pathogens during these natural disasters. The occupational risks of the transmission of microorganisms to funeral home workers and pathology personnel are well known, and similar risks would be expected to exist for emergency and disaster relief workers. Most of the risks for bloodborne pathogens occur as the result of percutaneous injury or mucous membrane splashes. The risks and preventive

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strategies in these settings have been well documented (10). It is important to recall that HIV may remain viable in the human body after death for up to 16 days if the body has been stored at low temperatures (2°C) (11). Corpses commonly leak fecal matter, and persons handling the corpses can be exposed to organisms that may naturally exist in the gastrointestinal tract. This contact may occur through direct means with the body or indirectly through contact with the immediate contaminated environment, such as clothing, stretchers or leaking body bags. Tubercle bacilli may remain viable for extended periods of time in cadavers (12), and opportunities for aerosolization may occur when handling bodies (13). The usual exposures occur from the purging of retained fluids and/or the expulsion of air from the respiratory tract due to the putrefaction process and fluid/air buildup, particularly when the body is moved. The risk of aerosolization of any pathogenic respiratory tract organisms may be reduced by masking or placing a cloth over the mouth of the corpse.

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