"But for the Hurricane": Measuring Natural Disaster Mortality over the Long Term

Lori Uscher-Pines, MSc, PhD Candidate

Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland USA

Correspondence:
Lori Uscher-Pines
Johns Hopkins Bloomberg School of Public Health, HPM
1358 Indian Creek Dr.
Wynnewood, PA 19096 USA
E-mail: luscher@jhsph.edu

Web publication: 27 April 2007

Dear Editor:

Impact assessments of disasters caused by natural hazards usually measure mortality for only a few weeks following an event, and studies that count death totals for one year or more are rare.[1–3] Limited surveillance periods are problematic and may result in an underestimation of mortality since the delayed, indirect deaths are not included.[4] A lack of resources may explain the limited, longer-term surveillance. Additional barriers to conducting more thorough, extended assessments include the challenges of attributing a delayed death to a specific event and the misguided belief that a few weeks of follow-up are sufficient to identify relevant impacts.[5] There is no universally accepted, standard definition for a disaster-related death, and the definition of "indirect death" remains particularly vague and subject to inconsistent application.[4,6] Researchers, first responders, and public health planners must use common definitions in order to effectively describe and communicate the impact of an event. They also can use such definitions to inform post-event surveillance activities (e.g., content and duration). The aim of this comment is to capture Lew and Wetli's approach to their study of Hurricane Andrew-related mortality, to record those deaths that, "but for the hurricane, would not likely have occurred."[7]

Limited examples of research on delayed, disaster-related mortality are available in the literature. However, it seems that certain hazards (e.g., those linked to diseases with known latency periods) are more likely to receive ongoing attention than others. After decades of ongoing surveillance, experts continue to attribute deaths to radiation events, such as Chernobyl and the atomic bombings in Japan.[8] The Indian Council of Medical Research followed a cohort of people exposed to methyl isocyanate gas in Bhopal, India from 1985–1994 and counted delayed deaths.[9] Also, systems are in place to monitor the residents and recovery workers exposed to toxic dust during and after the terrorist attacks of 11 September 2001. The perception may be that disasters caused by natural hazards, such as floods or tornados, do not appear to be enduring threats. Thus, experts seldom count deaths displaced in time from the event of interest.

The experience from Hurricane Katrina demonstrates how inappropriate surveillance and classification has clear implications for preparedness and response. Hurricane Katrina, which made landfall in southeastern Louisiana on 29 August 2005 and quickly resulted in flooding the New Orleans metropolitan area, is among the five deadliest hurricanes in US history.[10] As is the case in many disasters, impact assessments have estimated the death toll for only the period immediately following the event. As of May 2006, the Louisiana Department of Health had recorded 1,577 direct or indirect storm-related deaths of residents between 27 August and 01 October 2005.[11] Currently, no assessments of Katrina death totals beyond October have been conducted. However, there is anecdotal evidence—such as the observations of healthcare workers and the number of death notices in the *Times-Picayune* (up 25% from January 2005 to January 2006 despite reduced population)—that the death rate has increased post-Katrina. This increase may be due to the stress that is exacerbating underlying health conditions.[11] In order to adequately design pre- and post-disaster interventions, additional information about the magnitude and scope of these trends is needed.

The common classification of disaster mortality, which includes direct and indirect deaths, is insufficient for capturing the enduring impacts (such as the

Definition	Examples	Timeframe
Direct Death	Drowning in floodwaters; head trauma from debris	Immediate death or immediate injury that causes delayed death
Indirect Death	Suicide; fatal injury occurring during clean-up; post-disaster pulmonary embolism as a result of sheltering in motor vehicles[19]	Immediate: 2 weeks post-disaster
Disaster-Triggered Deaths	Death resulting from disruption of care for year post-disaster chronic illness; suicide	2 weeks post-disaster to 1 year post-disaster

Table 1—Demographic information by wave of data collection

exacerbation of underlying chronic illness) of disasters caused by natural hazards on populations. The modified scheme outlined in this discussion can be applied to link individual, delayed deaths to a precipitating event such as Hurricane Katrina. Improved classification can provide disaster planners with critical information in order to design recovery interventions.

Common Classification Schemes

In standard, but slightly variable definitions, direct death in disasters caused by natural causes is attributed to the environmental or physical force of the disaster, and indirect death is attributed to unsafe or unhealthy conditions that exist through the recovery phase.[6] Indirect deaths may include (but are not limited to): (1) suicides and homicides;[7] (2) accidents during the recovery phase;[4] (3) traffic crashes during relocation;[13] (4) cardiovascular deaths that occur as a result of shock or stress;[7] and (5) exacerbation of pre-existing medical conditions that contribute to death.[14] There are no explicitly identified time frames in which the causes of indirect deaths are documented, therefore planners cannot adequately compare mortality across studies and disasters.

As anecdotal evidence suggests, there may be many disaster-related deaths that are not recorded due to limited surveillance periods and inappropriate definitions and criteria. For example, if the Louisiana Department of Health maintains the 1,577 death total of Hurricane Katrina, it may overlook those deaths that extend far beyond the initial insult. This could result in a distortion of the true effects of the disaster, with unfortunate implications for the ongoing recovery and future prevention and response activities.

The vague concept of indirect death is problematic and in need of clarification. Adequately assessing the causes of indirect death is of paramount importance because it often is more feasible to intervene and limit the secondary effects rather than the direct effects of the precipitating event. Thus, maintaining detailed data on the incidence and risk factors for secondary (delayed) effects is critical for prevention.[6] Combs *et al* recognized the lack of rigor in the literature with respect to crucial definitions and proposed a new scheme. However, in failing to implement standard time frames for the classification of disaster-related deaths and leaving such decisions up to individual investigators, they did not resolve one of the major weaknesses in the current methods of classification.[15] One additional and strikingly different method for measuring disaster mortality uses the concept of years of potential-life-lost (YPLL), an indicator of premature mortality that takes into account the victim's age at death.[16] Researchers can compare the YPLL in disaster victims and non-victims. While this indicator is useful in describing the overall impact of a disaster on populations and the cost to society, it does not provide criteria for surveillance duration.

Proposed Classification Scheme

Deaths resulting from disasters should be labeled as: "direct", "indirect", or "disaster-triggered". The definition of direct death remains unchanged (i.e., death attributed to the environmental or physical force of the event(s)). However, indirect deaths are limited to a period of two weeks following the event, a period previously defined in the literature as the "acute excitement and response phase."[7] Although there is a precedent for the selection of this time frame, and it seems appropriate for the application to most disasters caused by natural hazards, two weeks is somewhat arbitrary. In certain isolated cases in which responses and recovery are prolonged, a longer time period may be justified. The third category of disaster-triggered death encompasses the period beyond two weeks. Further research will be required to determine the cut-off date for this category, but six to 12 months may be adequate. One study suggests that mortality rates reach a steady state—although elevated from pre-event levels—within six months of the event.[17] It is important to emphasize that technological disasters may cause direct deaths that are displaced in time from the actual event (e.g., death from thyroid cancer years later.) The scheme outlined here is more suited to typical disasters caused by natural events, since when floods or winds pass, the primary insult is removed.

There will be some overlap in the causes of death in the categories of indirect and disaster-triggered mortality. For example, suicides and exacerbations of medical conditions that result in death may appear in either category (but not both) depending on their timing. However, the purpose of the third category, disaster-triggered mortality, is to fully capture the role of poor chronic disease management and the interaction of stress and underlying physical or mental

conditions in deaths caused by disasters. Medical errors that occur in the absence of patient medical records and lead to eventual death also are relevant. The use of the third category depends on the report of third parties (e.g., relatives and healthcare providers of the deceased). Thus, surveillance systems may have to adapt in order to tap new sources of information over longer periods.

At this time, it is unclear whether Hurricane Katrina will look more like a natural disaster whose main effects will manifest within months or years, or a chemical or radiological disaster, which justifies decades of surveillance. Some speculate that exposure to floodwaters—with contaminants such as lead, arsenic, and petroleum—poses certain health risks.[18] Thus, long-term surveillance is especially important. To begin to apply the classification of disaster-triggered mortality to actual practice, planners can use medical claims databases to identify a sample of (insured) patients with chronic illnesses. Chronically ill patients that show evidence of (greater than expected) post-Katrina deterioration, and subsequent death then become the targets of further investigation (i.e., direct request for third-party reports on the likely role of Katrina.)

The new scheme proposed in this discussion allows planners to better compare the long-term impacts of different events by using standardized definitions. Furthermore, by tracking delayed impact, this scheme encourages longer-term surveillance. It is clear that without adopting a more nuanced approach to classifying mortality in disasters caused by natural hazards, the public health community fails to fully understand—and consequently to prepare for—the enduring impacts of such events.

References

1. Malilay J: Public health assessments in disaster settings. *Prehosp Disast Med* 2000;15(4):167–172.
2. Bennet G: Bristol floods 1978. *Br Med J* 1970;3(5720):454–458.
3. Chan C, Lin YP, Chen HH, *et al*: A population based study on the immediate and prolonged effects of the 1999 Taiwan earthquake on mortality. *Ann Epidemiol* 2003;13(7):502–508.
4. Jani A, Fierro M, Kiser S: Hurricane Isabel-related mortality—Virginia, 2003. *J Public Health Manag Pract* 2006;12(1):97–102.
5. Jonkman S, Kelman I: An analysis of the causes and circumstances of flood disaster deaths. *Disasters* 2005;29(1):75–97.
6. (US) Centers for Disease Control and Prevention (CDC): Mortality associated with Hurricane Katrina. *MMWR* 2006;55(9):239–242.
7. Lew E, Wetli C: Morality from Hurricane Andrew. *J Forensic Sci* 1996;41(3):449–452.
8. Williams D, Baverstock K: Chernobyl and the future: Too soon for a final diagnosis. *Nature* 2006;440(7087):993–994.
9. Sharma D: Bhopal: 20 years on. *Lancet* 2005;365(9454):111–112.
10. Knabb R, Rhome J, Brown D: *Tropical Cyclone Report: Hurricane Katrina.* National Hurricane Center, 2005.
11. Louisiana Department of Health: Katrina missing. Available at http://www.dhh.louisiana.gov/offices/page.asp?ID=192&Detail=5248. Accessed 10 June 2006.
12. Berggren R, Curiel T: After the storm. *N Engl J Med* 2006;354(15):1549–1552.
13. Martel B: *Out of State Reports of Katrina-Related Deaths Raise Louisiana's Official Toll.* Associated Press 19 May 2006.
14. (US) Centers for Disease Control and Prevention: Preliminary medical examiner reports of mortality associated with Hurricane Charley. *MMWR* 2004;53(36):835–837.
15. Combs D Quenemoen LE, Parrish RG, Davis JH: Assessing disaster-attributed mortality: Development and application of a definition and classification matrix. *Int J Epidemiol* 1999;28:1124–1129.
16. Li X, Tan H, Li S, *et al*: Years of potential life lost in residents affected by floods in Hunan, China. *Trans R Soc Trop Med Hyg* 2007;101(3):299–304.
17. Aremenian H, Melkonian A, Hovanesian A: Long-term mortality and morbidity related to degree of damage following the 1988 earthquake in Armenia. *Am J Epidemiol* 1998;148(11):1077–1084.
18. Presley SM, Rainwater TR, Austin GP, *et al*: Assessment of pathogens and toxicants in New Orleans LA following Hurricane Katrina. *Environ Sci Technol* 2006;40(2):468–474.
19. Ukai T: New type of preventable death. *Prehosp Disast Med* 2005;20(3):202 (Letter).