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Mortality Associated with Hurricane Katrina --- Florida and Alabama, August--October 2005

On August 25, 2005, Hurricane Katrina made landfall between Hallandale Beach and Aventura, Florida, as a Category 1 hurricane, with sustained winds of 80 mph. Storm effects, primarily rain, flooding, and high winds, were substantial; certain areas reported nearly 12 inches of rainfall (*1*). After crossing southern Florida and entering the Gulf of Mexico, the hurricane strengthened and made landfall in southeastern Louisiana on August 29 as a Category 3 hurricane, with sustained winds of 125 mph. Katrina was one of the strongest hurricanes to strike the United States during the past 100 years and was likely the nation's costliest natural disaster to date (*2*). This report summarizes findings and recommendations from a review of mortality records of Florida's Medical Examiners Commission (FMEC) and the Alabama Department of Forensic Science (ADFS). CDC was invited by the Florida Department of Health (FDOH) and the Alabama Department of Public Health (ADPH) to assess the mortality related to Hurricane Katrina. The mortality review was intended to provide county-based information that would be used to 1) define the impact of the hurricane, 2) describe the etiology of deaths, and 3) identify strategies to prevent or reduce future hurricane-related mortality. Combined, both agencies identified five, 23, and 10 deaths, respectively, that were directly, indirectly, or possibly related to Hurricane Katrina (Figure). Information from the characterization of these deaths will be used to reduce hurricane-related mortality through early community awareness of hurricane-related risk, prevention measures, and effective communication of a coordinated hurricane response plan.

Florida law requires that traumatic deaths (including hurricane-related deaths), deaths that occur under unusual or suspicious circumstances, and deaths associated with diseases that pose a threat to public health be referred to the local medical examiner (ME).* All 67 Florida counties are under the jurisdiction of ME offices. When MEs receive death reports of public health importance, specifically those related to hurricanes, they report the information to FMEC. During hurricane season (June 1--November 30), deaths associated with hurricanes are reported twice daily. FDOH also reviews copies of final death certificates and medical examiner documentation. This mortality surveillance, in place since the beginning of the 2004 hurricane season, is part of the standard procedure for FDOH hurricane response. FMEC and the FDOH Bureau of Epidemiology collected and analyzed data for this review.

Similarly, ADFS collects and reviews data for all deaths in Alabama that are unintentional, intentional, or of undetermined cause. On October 5--6, 2005, CDC reviewed ADFS forensic records and logbooks and interviewed forensic MEs regarding specific cases in Baldwin and Mobile counties in Alabama. Data such as demographic characteristics, circumstances, causes, and dates of deaths potentially related to Hurricane Katrina were abstracted using a case report form. Additional cases were identified by the MEs during follow-up telephone calls.

A directly related death was defined as a death caused by the physical forces of a hurricane, whereas an indirectly related death was one caused by unsafe or unhealthy conditions that existed during the evacuation

phase, occurrence of the hurricane, or post-hurricane/cleanup phase (*3*). A case was classified as possibly related to the hurricane if 1) the death occurred in the hurricane-affected area during August 23--October 23, 2005, 2) the cause or manner of death was undetermined or pending, and 3) reviewers agreed that a possible relation between the death and the hurricane might exist. Natural causes of death were considered storm-related if physical or mental stress before, during, or after the storm resulted in exacerbation of preexisting medical conditions and contributed to death.

Florida. Fourteen deaths from Florida's Miami-Dade, Broward, and Walton counties were identified as being directly, indirectly, or possibly related to Hurricane Katrina during August 25--September 1 (Table). Decedents ranged in age from 17 to 79 years (mean: 53 years; median: 58 years); 71% were male. Of the 14 deaths, 13 (93%) were classified as resulting from unintentional injuries, and one was listed as "manner undetermined pending further studies." The majority (79%) of deaths occurred during the impact phase (August 25, 26, and 29), with only three occurring after impact. Of the 13 deaths for which no cause or manner was determined, eight (62%) were attributed to trauma, three (23%) to drowning, and two (15%) to carbon monoxide poisoning.

Of the 14 deaths, five were directly related to the hurricane: two persons drowned on boats that sank during the storm, two died from trees falling on them during the hurricane, and one was found floating in the water after the hurricane. Eight deaths were indirectly related: three persons died in car collisions with fallen trees in the road, two were struck and killed by falling tree limbs during cleanup, one sustained fatal injuries from a fall off a ladder after the hurricane, and two died from carbon monoxide poisoning as a result of generator use in a laundry room adjoining the residence.

Alabama. A total of 24 deaths from Mobile and Baldwin counties were identified as being indirectly or possibly related to Hurricane Katrina during August 27--October 17 (Table). Decedent ages ranged from 6 months to 77 years (mean: 46 years; median: 52 years); 88% were male. Thirteen (54%) deaths were categorized as natural deaths. Five (21%) deaths were attributed to intentional injuries (three assaults and two suicides); four (17%) to unintentional injuries; and two (8%) to injuries with intent undetermined (one trauma-related and one with unknown cause).

Fifteen (63%) of the 24 deaths were indirectly related to the hurricane, including deaths resulting from injuries incurred while working on hurricane cleanup, and natural deaths exacerbated by hurricane conditions. Six of the indirectly related deaths were associated with underlying cardiovascular disease and two with other preexisting diseases (i.e., sepsis from infected diabetic ulcers and complications of chronic alcoholism). Two children died naturally: one child had cerebral palsy and suffered a fatal seizure while being moved to a shelter, and another had preexisting central nervous system disease, which was exacerbated by stress. Five of the indirectly related deaths were trauma related: one man had onset of multiple hernias during cleanup, became incapacitated, and committed suicide by a gunshot to the chest; one person died during evacuation in a car collision involving a drunk driver; a homeless man with an unexplained head injury was found dead after the hurricane, although no foul play was suspected; a girl aged 6 years drowned when she climbed onto a fallen tree and fell into a neighbor's swimming pool; and an infant aged 6 months suffocated while sharing a bed with his mother after evacuation.

Nine deaths were possibly hurricane-related; these included suicides, assaults, and natural causes. Three men were shot during possible looting incidents after the hurricane, one man was struck by a tree that was being cut during cleanup, and one man committed suicide by hanging the day after the hurricane. Three deaths were associated with underlying cardiovascular disease; however, the circumstance of the deaths indicated a possible association with the hurricane. The cause of one death was undetermined; the decedent, who had a history of heavy drinking and cocaine use, was found dead during the hurricane. No deaths in Alabama were categorized as directly related.

Reported by: *S Nelson, MD, Florida Medical Examiners Commission; J Luten, Florida Dept of Law Enforcement; K Jones, Florida Office of Vital Statistics; P Ragan, PhD, Bur of Epidemiology, Florida Dept of Health. L Riddick, MD, E Hart, MD, Alabama Dept of Forensic Sciences. J Schulte, DO, National Center for Health Marketing; L Corrales, MPH, D Combs MPH, A Wolkin, MSPH, H Strosnider, MPH, D Batts, MD, Div*

of Environmental Hazards and Health Effects, National Center for Environmental Health; T Bayleyegn, MD, EIS Officer, CDC.

Editorial Note:

Mortality surveillance after natural or manmade disasters plays a critical role in evaluating the cause, manner, and circumstances of disaster-related deaths (*4*). An understanding of attributable factors and the relation between disasters and mortality is useful for developing and implementing policies to prevent disaster-related mortality. In Florida, the review of death records associated with Hurricane Katrina indicated that trauma directly or indirectly related to the hurricane was the leading cause of death, which is consistent with reported deaths associated with previous hurricanes (*4*--*6*). However, the majority of deaths occurred during the impact phase; the rapid (<24 hours) strengthening of Katrina from a tropical storm to a hurricane and the subsequent landfall later the same day likely left many residents unprepared.

In Alabama, most of the deaths were attributed to indirect causes, both natural and traumatic; the majority of these deaths were from natural causes exacerbated by the hurricane. Persons with preexisting medical conditions can die when access to care is interrupted. Mental stress associated with evacuation, change in residence or work, property damage, and loss of human life might increase in communities affected by hurricanes and can lead to suicide in persons with a history of psychological problems. Violent behavior also might escalate. Moreover, increased use of alcohol or drugs might contribute to a greater incidence of car collisions, violence, and unintentional injuries (*7*).

The majority of Hurricane Katrina--related deaths occurred in Louisiana and Mississippi (*8*). The deaths described in this report are not representative of Katrina-related deaths. Furthermore, the findings in this report are subject to at least three limitations. First, a universally accepted standard definition of a hurricane-related death has not been established. The classification of a direct, indirect, or possible hurricane-related death is based on the circumstances of death, availability of information, and individual judgment, which might lead to over- or underreporting. Second, entry of certain records and interviews with MEs occurred 5 weeks after landfall, increasing the likelihood of recall bias regarding the circumstances of deaths. Finally, background information in some of the medical records was incomplete or insufficient, which presented difficulties in determining the circumstances of those deaths. In such cases, the logbook review and interview of the ME provided additional information.

The mortality report after Hurricane Katrina provided information to FDOH, ADPH, and CDC regarding the characteristics of deaths in the affected communities. Agencies can use these results in future public health interventions during hurricane preparation, warning, and response periods to address the direct and indirect effects of hurricanes. In addition, MEs, coroners, and state and federal health agencies should continue to collaborate to establish procedures for active mortality surveillance during hurricane season.

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* The 2005 Florida statutes. Available at http://www.leg.state.fl.us/statutes/index.cfm.

Table

TABLE. Number of deaths directly, indirectly, or possibly related to Hurricane Katrina, by cause of death — selected counties,* Florida and Alabama, August–October 2005

	Florida					Alabama			
Cause of death	**Direct**	**Indirect**	**Possible**	**Total**	**(%)**	**Indirect**	**Possible**	**Total**	**(%)**
Drowning	3			3	(21)	1		1	(4)
Car collision		3†		3	(21)	1		1	(4)
Hit by falling tree limb	2	2		4	(29)				
Carbon monoxide poisoning		2		2	(14)				
Fall from ladder		1		1	(7)				
ASCVD§						6	3	9	(38)
Chronic alcoholism						1		1	(4)
Sepsis						1		1	(4)
Seizure						1		1	(4)
Other CNS¶ disease						1		1	(4)
Traumatic brain injury						1	1	2	(8)
Homicide (gunshot wound)							3	3	(13)
Suicide						1	1	2	(8)
Asphyxia						1		1	(4)
Undetermined			1	1	(7)		1	1	(4)
Total	**5**	**8**	**1**	**14**		**15**	**9**	**24**	

* Surveillance covered all 67 counties in Florida and Baldwin and Mobile counties in Alabama.
† Two deaths in Walton County were associated with weather conditions during the second landfall of Hurricane Katrina.
§ Atherosclerotic cardiovascular disease.
¶ Central nervous system.

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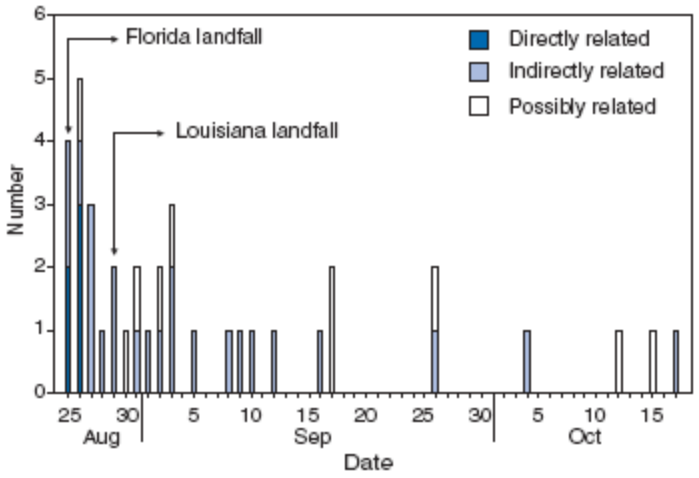
Figure

FIGURE. Number of deaths related to Hurricane Katrina (directly, indirectly, and possibly), by date — selected counties,* Florida and Alabama, August–October 2005



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