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Deaths Related to Hurricane Andrew in Florida and Louisiana, 1992

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Background. Information about circumstances leading to disaster-related deaths helps emergency response co-ordinators and other public health officials respond to the needs of disaster victims and develop policies for reducing the mortality and morbidity of future disasters. In this paper, we describe the decedent population, circumstances of death, and population-based mortality rates related to Hurricane Andrew, and propose recommendations for evaluating and reducing the public health impact of natural disasters.

Methods. To ascertain the number and circumstances of deaths attributed to Hurricane Andrew in Florida and Louisiana, we contacted medical examiners in 11 Florida counties and coroners in 36 Louisiana parishes.

Results. In Florida medical examiners attributed 44 deaths to the hurricane. The mortality rate for directly-related deaths was 4.4 per 1 000 000 population and that for indirectly-related deaths was 8.5 per 1 000 000 population. In Louisiana, coroners attributed 11 resident deaths to the hurricane. Mortality rates were 0.6 per 1 000 000 population for deaths directly related to the storm and 2.8 for deaths indirectly related to the storm. Six additional deaths occurred among non-residents who drowned in international waters in the Gulf of Mexico. In both Florida and Louisiana, mortality rates generally increased with age and were higher among whites and males.

Conclusions. In addition to encouraging people to follow existing recommendations, we recommend emphasizing safe driving practices during evacuation and clean-up, equipping shelters with basic medical needs for the population served, and modifying zoning and housing legislation. We also recommend developing and using a standard definition for disaster-related deaths, and using population-based statistics to describe the public health effectiveness of policies intended to reduce disaster-related mortality.

Keywords: death investigation, disaster epidemiology, hurricanes, mortality, natural disasters

Mortality is an easily measured endpoint for those studying the public health impact of a natural disaster. Information about the circumstances leading to disaster-related deaths may help emergency response co-ordinators and other public health officials respond to the needs of disaster victims and develop policies to reduce mortality and morbidity associated with future disasters. Furthermore, the effectiveness of these policies can be adequately assessed only by evaluating population-based mortality. Many investigators report a general description of mortality and morbidity among the disaster victims,[1–4] information that is useful in determining the circumstances and individual characteristics associated with risk. Fewer, however, report population-based statistics,[5–6] which can help public health officials determine how to target prevention policies toward populations at greatest risk and evaluate the effectiveness of these policies over time, in different places, and for different types of disasters.

In this paper, we describe the decedent population, the circumstances of their deaths, and the population-based mortality rates related to Hurricane Andrew, the first Atlantic hurricane of the 1992 hurricane season. We also propose recommendations for reducing the public health impact associated with future disasters, and recommend incorporating additional methods for evaluating disaster-related mortality.

BACKGROUND

At 5:05 am eastern daylight time on 24 August 1992, Hurricane Andrew, a Category 4 storm on the Saffir-Simpson scale, made landfall in Florida. The eye of the storm passed through Homestead Air Force Base (AFB), 35 miles southeast of Miami, with maximum sustained surface wind speeds estimated at 145 miles per hour (mph) and gusts estimated at 175 mph. The high force winds extended 35 miles from the storm centre, which moved west across the state at 16 miles per hour.[7]

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Hurricane Andrew reached Florida almost concurrently with high tide. The highest storm tide* (16.9 feet) and maximum storm surge† (14.6 feet) were recorded a few miles north of Homestead AFB.[7]

In Florida, reports showed that the maximum rainfall of 7.8 inches occurred in Broward County. Dade County received 7.4 inches; other counties along the eastern Florida coast received from 2.0 to 5.2 inches.[7] Although land elevations in southeastern Florida are near sea level, minimal flooding occurred in the heavily populated areas; and, in spite of the high storm surge and rainfall, Hurricane Andrew was considered to be a relatively dry storm in Florida.

After crossing Florida and then the Gulf of Mexico, Hurricane Andrew made landfall at Point Chevreuil, in south-central Louisiana, at 3:30 am central daylight time on 26 August. By the time the hurricane reached Louisiana, it had weakened to a Category 3 storm with sustained winds of 120 mph. In Louisiana, the most severe wind damage resulted from tornadoes that occurred a few hours before Hurricane Andrew made landfall.[7]

In Louisiana, the highest storm surge was 8.2 feet along East Cote Blanche Bay. As a result of the storm surge, flooding occurred from Lake Borgne westward through Vermillion Bay. Several locations in Louisiana received at least 7 inches of rainfall, causing widespread local flooding. The highest recorded rainfall related to the hurricane (11.9 inches) occurred in Hammond, Louisiana. Other areas received from 4.4 to 11.0 inches of rain.[7]

METHODS

Because medical examiners and coroners are required by law to investigate sudden, unnatural, and unexpected deaths, we contacted medical examiner's and coroner's offices in Florida and Louisiana to obtain reports of deaths that were related to the hurricane. Each office was asked to supply demographic information about the decedent; time and date of death; and cause(s), manner, and circumstance of death for any death that occurred in its legal jurisdiction (e.g. district, county, parish [equivalent to a county]).

Florida

Florida has 24 death investigation jurisdictions, called districts, each containing one or more counties. Each district is served by a medical examiner, who must be a practising pathologist and who is appointed by the governor to serve a 3-year renewable term.[8]

We telephoned eight district medical examiner offices (covering a total of 11 counties) to obtain reports of hurricane-related deaths. Offices were contacted if (1) evacuation orders were issued to residents in the district, (2) any area of the district was in the path of the storm, or (3) the district was adjacent to another district in which deaths were reported to have occurred. In addition to making initial calls during the first few weeks following the storm, we also made follow-up telephone calls from November 1992 through February 1993.

Medical examiners were asked to report any death that they attributed to the direct or indirect effects of the hurricane. Although the criteria for determining hurricane-related deaths were left to the discretion of each medical examiner, generally, a death was considered to be directly related if the environmental force of the hurricane (e.g. wind, storm surge) resulted in death. An indirectly-related death was one resulting from any other hurricane-related event, such as evacuation or clean-up.

The time period for which deaths could be classified as hurricane-related was also left to the discretion of the medical examiner, and only one medical examiner established time criteria for hurricane-related deaths. In Dade County, deaths were excluded if the circumstances that led to death occurred after 7 September 1992.

Louisiana

In Louisiana, each of the 64 parishes constitutes a death investigation jurisdiction that is served by a coroner. The coroner must be a licensed physician and is elected by the parish voters every 4 years.[8]

Approximately 2 days before the storm, the Louisiana Office of Public Health telephoned coroners in 19 parishes to request that the coroners, using a standard report form developed by the Office of Public Health, supply information about hurricane-related deaths. Coroners in an additional 17 counties were sent copies of the form and asked to report any hurricane-related deaths to the Office of Public Health. Hurricane-related deaths were defined as those occurring between noon on 24 August and midnight on 21 September that resulted directly or indirectly from the preparation for, impact of, or clean-up after the hurricane.

* The storm tide, also called the tidal surge, is the actual height of the water as the hurricane moves inland. It is the sum of the height of the astronomical high tide and the height of the storm surge.

† The storm surge is the sudden rise in sea level above normal tide, resulting from the low pressure associated with the eye of the hurricane, the wind-driven water, and the topography and bathymetry of the coastline.

TABLE 1 *Demographic characteristics of Hurricane Andrew decedents by category of death, Florida, 1992*

Age group (years)	Gender								Total				Total deaths[a]	
	Male (N = 31; rate[b] = 18.8)				Female (N = 13; rate = 7.3)									
	Direct		Indirect		Direct		Indirect		Direct		Indirect			
	N	rate	N	rate	N	rate	N	rate	N	rate	N	rate	N	rate
0–17	0	0.0	2	5.1	1	2.7	2	5 3	1	1.3	4	5.2	5	6.5
18–24	0	0.0	1	6.4	0	0.0	0	0.0	0	0.0	1	3.2	1	3.2
25–44	3	5 6	4	7.5	0	0.0	1	1.8	3	2.8	5	4.6	8	7 4
45–64	7	21.6	4	12.3	1	2.8	1	2.8	8	11.7	5	7.3	13	19.1
≥65	2	8.5	8	33.9	1	2 9	6	17.5	3	5.2	14	24.2	17	29.4
Total deaths	12	7.3	19	11.5	3	1 7	10	5.6	15	4.4	29	8.5	44	12.9

[a] Total ratios may appear in error because of rounding.
[b] Mortality ratios are expressed as numbers of deaths per 1 000 000 resident population (Bureau of the Census, 1990) for Dade, Broward, Collier, and Monroe Counties.

Calculating Rates

We calculated mortality rates by dividing the number of resident deaths by the 1990 resident population (as reported by the US Bureau of the Census) of the counties or parishes most affected by the hurricane (which we defined as those receiving financial assistance from the Federal Emergency Management Agency). Rates are reported as the number of deaths among state residents per one million residents.

RESULTS

Florida

Medical examiners reported a total of 44 hurricane-related deaths, all of which occurred in two of the 11 counties surveyed. The mortality rate was 12.9 per 1 000 000 population (Table 1). Fifteen deaths were directly related to the hurricane; 29 deaths were indirectly related. The mortality rate for directly-related deaths was 4.4 per 1 000 000 population and that for indirectly-related deaths was 8.5 per 1 000 000 population.

Of the 15 deaths directly related to the hurricane, 13 occurred when buildings collapsed or trailers rolled over, causing death from either blunt trauma (9) or asphyxia (4). The remaining two deaths were from drowning (Table 2).

Twenty-nine deaths, including 13 accidental* deaths, were indirectly related to the hurricane (Table 2). Accidental deaths were caused by blunt trauma during clean-up or preparation for the storm (2), falls from damaged buildings or caused by slipping on wet surfaces (3), and transportation-related events (plane crash [2]; automobile collision [1]); fire-related injuries while alternative energy sources were being used (2 children in a house fire); electrocution (1); complications from a lightning strike (1); and mechanical asphyxia at a shelter (1 infant).

The 16 natural deaths were caused by stress-induced cardiovascular events (12), volume depletion and hypoglycaemia (1), hyperkalaemia and schizophrenia (1), inanition due to organic brain syndrome (1), and fetal death (1) caused by maternal death from cerebral haemorrhage.

At least 17% (5/29) of the indirectly-related deaths occurred among volunteers assisting hurricane victims. Three died while delivering supplies to hurricane victims (plane crash [2], heart attack [1]) and two volunteers died during clean-up activities (blunt trauma [1], complications from a lightning strike [1]).

Age. The decedents' ages ranged from a viable fetus of 31 weeks gestation to 94 years. The age range for decedents whose deaths were directly related to the storm was slightly narrower (12–80 years). The median age for all decedents was 54.5 years. Decedents were more likely to be younger if death was directly related to the storm (median age of 49 years compared with 63 years for those whose deaths were indirectly related), although a smaller proportion of directly-related deaths occurred among children (<18 years of age). Children

* 'Accidental' is a medicolegal term used to describe unintentional injuries.

TABLE 2 *Causes of death directly and indirectly related to Hurricane Andrew, Florida and Louisiana[a], August 1992*

	Florida	Louisiana
Directly related deaths:		
Blunt trauma	9	2
Asphyxia	4	0
Drowning	2	0
Subtotal	15	2
Indirectly related deaths:		
Blunt trauma due to:		
Clean-up or preparation for storm	2	1
Falls from damaged buildings	2	0
Falls from slipping on wet surfaces	1	0
Plane crash while transporting supplies	2	0
Auto collision during evacuation	0	2
Auto collision after the storm	1	0
Mechanical asphyxia at a shelter	1	0
Fire-related injuries while using alternative energy sources	2	1
Electrocution	1	2
Complications from lightning strike	1	0
Natural deaths occurring prematurely		
Stress-induced cardiovascular events	12	3
Volume depletion and hypoglycaemia	1	0
Hyperkalaemia and schizophrenia	1	0
Inanition due to organic brain syndrome	1	0
Death of a viable fetus[b] caused by maternal death from cerebral haemorrhage	1	0
Subtotal	29	9
Total	44	11

[a] Does not include [Excludes] six decedents—Asian males aged 25–44 years—who were not residents of Louisiana.

[b] Statistics about fetal deaths are reported separately from those about other deaths, and are generally excluded from counts of total deaths. However, for purposes of this paper, the death of a viable fetus was included because the fetus might have survived if medical care had not been interrupted by the hurricane.

accounted for 7% (1/15) of the directly-related deaths and 14% (4/29) of the indirectly-related deaths.

Decedents whose deaths were directly related to the storm were less likely to be elderly (≥65 years) than were decedents whose deaths were indirectly related to the storm. Elderly people accounted for 20% (3/15) of directly-related deaths compared with 48% (14/29) of indirectly-related deaths.

In general, mortality rates increased with age, with the highest rate of 29.4 per 1 000 000 population occurring among the elderly. However, among people whose deaths were directly related to the hurricane, the highest rate of 11.7 deaths per 1 000 000 population occurred among those 46–64 years of age. Among people whose deaths were indirectly related to the hurricane, the highest rate of 24.2 per 1 000 000 occurred among the elderly (Table 1).

Gender and race. Overall, 70% (31/44) of all decedents were male. Males accounted for 80% (12/15) of the deaths directly related to the storm and 66% (19/29) of the indirectly-related deaths.

The mortality rate among males was 18.8 per 1 000 000 population, compared with a rate of 7.3 among females. For both genders, mortality rates were higher for indirectly-related deaths than directly-related deaths. The rate for indirectly-related deaths was more than 1.5 times higher among males and more than three times higher among females than were the respective rates for directly-related deaths (Table 1).

Eighty-seven per cent (39/44) of all decedents were white. Decedents whose deaths were directly related to the storm were slightly more likely to be white (93%, 14/15) than were those whose deaths were indirectly related to the storm (86%, 25/29).

TABLE 3 *Demographic characteristics of Hurricane Andrew decedents[a] by category of death, Louisiana, 1992*

Age group (years)	Gender												Total deaths[b]	
	Male (N = 9; rate[c] = 5.8)				Female (N = 2; rate = 1.2)				Total					
	Direct		Indirect		Direct		Indirect		Direct		Indirect			
	N	rate	N	rate	N	rate	N	rate	N	rate	N	rate	N	rate
0–17	0	0.0	0	0.0	1	2.2	0	0.0	1	1.1	0	0.0	1	1.1
18–24	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
25–44	0	0.0	4	8.1	0	0.0	0	0.0	0	0.0	4	3.9	4	3.9
45–64	1	3.7	0	0.0	0	0.0	1	3.4	1	1.8	1	1.8	2	3.5
≥65	0	0.0	3	22.4	0	0.0	0	0.0	0	0.0	3	8.9	3	8.9
Unknown	0	n/a	1	n/a	0	n/a	0	n/a	0	n/a	1	n/a	1	n/a
Total deaths	1	0.6	8	5.2	1	0.6	1	0.6	2	0.6	9	2.8	11	3.4

[a] Does not include [Excludes] six decedents—Asian males between 25 and 44 years of age—who were not residents of Louisiana.
[b] Total ratios may appear in error due to rounding.
[c] Mortality ratios are expressed as numbers of deaths per 1 000 000 resident population (Bureau of the Census, 1990) for the following parishes: Acadia, Allen, Ascension, Assumption, Avoyelles, Calcasieu, Cameron, East Baton Rouge, East Feliciana, Evangeline, Iberia, Iberville, Jefferson, Jefferson Davis, Lafayette, Lafourche, Livingston, Orleans, Plaquemines, Point Coupee, Rapides, St Bernard, St Charles, St Helena, St James, St John the Baptist, St Landry, St Martin, St Mary, St Tammany, Tangipahoa, Terrebonne, Vermillion, Washington, West Baton Rouge, and West Feliciana.

The mortality rate among whites was more than one and a half times greater than the rate among blacks (14.7 deaths compared with 8.3 deaths per 1 000 000 population).

Louisiana

Coroners in 36 parishes reported a total of 11 hurricane-related deaths among state residents in six parishes, for a mortality rate of 3.4 per 1 000 000 population. Two deaths were directly related to the storm, and nine were indirectly related. Mortality rates were 0.6 per 1 000 000 population for deaths directly related to the storm and 2.8 per 1 000 000 population for deaths indirectly related to the storm (Table 3).

Two decedents whose deaths were directly related to the hurricane died from crush injuries that occurred when a hurricane-spawned tornado struck their homes the evening before Hurricane Andrew made landfall. Of the nine deaths indirectly related to the hurricane, three were from blunt trauma associated with automobile collisions (2) and clean-up (1); two were from electrocution, one was from fire-related injuries, and three were from stress-induced cardiovascular events (Table 2).

Age. Among the 10 decedents whose ages were reported, age ranged from 2 to 86 years, with a median of 44 years. Ten per cent (1/10) of all decedents were children and 30% (3/10) were ≥65 years.

The two people whose deaths were directly related to the hurricane were aged 2 years and 63 years. For those whose deaths were indirectly related, ages ranged from 33 to 86 years, with a median age of 47 years. (The age of one decedent was unknown.) The highest mortality rate (8.9 per 1 000 000 population) occurred among those ≥65 years (Table 3).

Gender and race. Eighty-two per cent (9/11) of all decedents were male. Half (1/2) of the directly-related deaths and 89% (8/9) of the indirectly-related deaths occurred among males. The mortality rate for males was almost five times higher than that for females (5.8 compared with 1.2 per 1 000 000 population). The mortality rate did not differ by gender for directly-related deaths; however, the rate for indirectly-related deaths was almost nine times higher for males than females (Table 3).

Eighty-two per cent (9/11) of the decedents were white and 18% (2/11) were black. Both those whose deaths were directly related to the storm were white. Among people whose deaths were indirectly related to the storm, 78% (7/9) were white and 22% (2/9) were black. The mortality rate per 1 000 000 population was 4.2 among whites and 2.1 among blacks.

Other deaths. Coroners in Louisiana also investigated six additional deaths that were directly related to the hurricane. These deaths occurred among non-Louisiana residents, Asian males, aged 25–44 years who drowned in international waters. All six decedents were aboard a 60-foot commercial fishing vessel that was in the Gulf of Mexico at the time of the storm. Because these deaths occurred among non-Louisiana residents, they have not been included in the description of the decedents; nor have they been included in the mortality rates.

DISCUSSION

Until recently, hurricanes in the US have resulted in a high number of deaths, with a predominance of drowning deaths.[9] However, mortality related to Hurricane Andrew was relatively low (considering the severity of the storm) because hurricane warnings were timely, and the storm missed major metropolitan areas.

Before landfall, Hurricane Andrew appeared to be heading for Miami and, later, New Orleans. However, the storm struck south of Miami and west of New Orleans, thus missing these heavily populated areas and reducing the number of people at risk.

Also critical to reducing the size of the population at risk were timely hurricane warnings that allowed evacuation of the populations at risk.[7] The National Weather Service issued a hurricane watch 36 hours in advance of Hurricane Andrew's landfall in Florida and 43 hours in advance of its landfall in south-central Louisiana.

Although eight people drowned as a result of the hurricane, none died because of the tidal surge on land. Seven drowning victims were aboard ocean-going vessels in the open sea and one was aboard a boat in a marina. All other deaths directly related to Hurricane Andrew were from wind-related trauma.

In addition to deaths directly related to the environmental impact of a hurricane, deaths indirectly related to the storm, such as those related to evacuation and clean-up, also occur; often, these are more numerous and as preventable as deaths directly related to the hurricane. Among residents in Louisiana, the number of deaths that resulted from the indirect effects of Hurricane Andrew was more than 4.5 times higher than the number of deaths from its direct effects. In Florida, nearly twice as many deaths were indirectly related to the hurricane than were directly related. In contrast to the indirectly-related deaths in Louisiana, however, approximately half of the indirectly-related deaths in Florida were from natural causes precipitated by stress or the inability to obtain therapeutic drugs or medical care. The number and type of indirectly-related deaths probably differ between the two states because of the larger proportion of the elderly in Florida, where 16.8% of the population in the counties affected by the hurricane were ≥65 years, compared with 10.6% in the affected parishes in Louisiana.

Limitations

When comparing hurricane-related deaths in Florida with those in Louisiana, one should consider several factors: the hurricane was less severe when it reached Louisiana; there was no standard definition for a disaster-related death in the two states; data collection methods and death investigation practices differed between the two states; and (because the population at risk is unknown) the mortality rates may be misleading.

A significant limitation of our current system for reporting disaster-related mortality is the lack of a case definition.[10–15] In Florida, we allowed each medical examiner to determine the criteria for a hurricane-related death and the time period within which disaster-related deaths could occur. In Louisiana, the Office of Public Health provided guidelines for determining a hurricane-related death as well as a time period within which the deaths could occur. The case definition for a hurricane-related death was, however, broader in Louisiana, thereby increasing the opportunity for deaths in Louisiana to be included.

In Florida, data collection occurred after the hurricane struck. However, in Louisiana, the Office of Public Health requested reports of deaths before the storm; thus, coroners in Louisiana may have been more likely to consider the role that the hurricane played in deaths than did medical examiners in Florida.

Although medical examiners and coroners are legally responsible for investigating deaths from disasters, death investigation practices differ by jurisdiction. In Florida and Louisiana, the qualifications required to hold office, the term of office, and the method of selecting officers differ. These differences may influence the perspective of an individual death investigator. In addition, staff of the medical examiner/coroner office may not be conducting the actual death scene investigation. This is especially true following a disaster, when resources may be limited or unavailable. Thus, if a medical examiner's or coroner's office relies on information collected from another agency, that office may not have access to sufficient information regarding the circumstances of death to make an accurate determination of the relationship of the effects of the disaster to death. This could lead to the inappropriate exclusion or inclusion of some cases during the preliminary investigation.

Deaths may also be excluded from the records of a medical examiner or coroner-based reporting system if a person injured within one death investigation jurisdiction died in another jurisdiction that was not included in the reporting area. Another type of death that might be omitted is one in which the decedent was hospitalized for 'late effects' resulting from an injury (e.g. bronchopneumonia). Because these deaths can occur several months following the injury, they may not be referred to the medical examiner or coroner for investigation.

Even if all hurricane-related deaths were reported and all reported deaths were actually hurricane related, mortality rates presented in this paper may be misleading because of the difficulty in determining the actual population at risk when the hurricane made landfall. The rates are based on populations of which an unknown but presumably large proportion evacuated. In spite of these limitations, the rates represent estimates of the effectiveness of current policy in reducing the public health impact of a hurricane.

RECOMMENDATIONS

Although early-warning and evacuation procedures modify the population at risk for disaster-related mortality, we recommend that population-based statistics be used for future epidemiological descriptions of mortality and morbidity related to natural disasters. Such statistics can measure the effectiveness of preventive measures, such as early warning, evacuation, and education messages, rather than the efficacy of the prevention tool itself. For example, safely removing a population from exposure is 100% efficacious; however, if only half of the population evacuates, the overall public health effectiveness of evacuation may be reduced to 50%. Until we report population-based statistics to describe the public health impact of a natural disaster, we will not be able to assess accurately the effectiveness of our prevention policies.

A more significant limitation to assessing the effectiveness of public health and emergency response activities in preventing disaster-related health effects is the lack of a case definition for disaster-related mortality and morbidity, which significantly limits the accuracy of our reporting system. Therefore, we strongly recommend the development and adoption of a standard definition in which the criteria for determining a disaster-related case are clearly defined.

A few months before the hurricane, public health recommendations to prevent deaths related to hurricanes were published. These recommendations are consistent with policies that are well-established among disaster preparedness and emergency response agencies, and were implemented in both Florida and Louisiana prior to Hurricane Andrew's landfall. These recommendations include evacuating people to safe locations, prohibiting boating during the pre-impact and impact phase of a storm, educating the public about the risk of fires related to the use of alternative energy sources, emphasizing the risk of traumatic injury and electrocution during the clean-up phase following a storm, and reminding electrical workers about the risk of electrocution while repairing electrical lines.[15,16] Although the effectiveness of these recommendations is difficult to evaluate, for reasons mentioned earlier, it should be noted that, although there were three electrocutions during clean-up, none was occupationally related.

In addition to following the above recommendations, residents should observe safe driving practices while evacuating and should evacuate before the storm arrives to avoid driving in hazardous weather conditions. People should be discouraged from driving in unfamiliar areas after the storm, especially if traffic controls, such as lights and signs, have been disabled or destroyed.

Local emergency response agencies should ensure that shelters are equipped to provide basic medical needs for the population served. For example, a large number of elderly people reside in the Miami area, and their needs are probably different from the needs of the younger population in south-central Louisiana. Therefore, shelters in Miami should have adequate supplies of medication for people with prevalent chronic conditions such as diabetes and cardiovascular disease.

Twenty-six per cent (6/23) of the those who died as a direct result of the storm were Asian fisherman in the Gulf of Mexico who may not have understood the hurricane warnings. Thus, hurricane warnings that are broadcast to ocean-going vessels need to be multilingual.

The most effective method of reducing morbidity and mortality from natural disasters is to remove people from risk. Although evacuation efforts were successful in Florida and Louisiana, evacuation requires significant manpower and financial resources. Fortunately, Hurricane Andrew missed two major metropolitan areas. However, if a hurricane of similar intensity was to strike directly a metropolitan area the size of Miami or New Orleans, the number of deaths might be much higher, even if evacuation efforts were successful.

Because we are incapable of preventing hurricanes and other natural disasters, we need to consider zoning

and housing legislation to minimize the number of people who may be affected by hurricanes and other natural disasters. When contemplating building in coastal areas, we need to consider seriously the risk to human life as well as the impact on the natural ecosystems that protect inland areas from flooding by providing buffer zones. The impact on the economy should also be considered. Property damage associated with Hurricane Andrew was greater than that associated with any other hurricane. To reduce these costs, we need to implement zoning laws that discourage development of vulnerable coastal areas, and those responsible for disaster assistance programmes need to evaluate the long-term effect of policies that allow rebuilding in areas prone to natural hazards.

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