

Hurricane Katrina's Impact on Infectious Disease Surveillance

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Hurricane Katrina and Rita made landfall on the United States Gulf Coast on August 29th 2005 and September 24th 2005 respectively. Katrina brought heavy winds and rain to Southeast Louisiana, breaching several levees and flooding up to eighty percent of New Orleans and large areas of Plaquemines and St. Bernard Parishes. Much of the area that was flooded in Hurricane Katrina was re-flooded by a storm surge from Hurricane Rita. Hurricane Rita came on shore on the Louisiana/Texas border bringing further damage from Cameron to Lafourche parishes through flooding from the storm surge and wind. These floods caused a massive evacuation of population to other parts of Louisiana and other states.

Although experience shows that the threat of massive epidemic after floods is very small in an industrialized nation,¹ there were concerns about the spread of infectious diseases among the population that was in contact with floodwaters and among the evacuees in the shelters. There was also concern about injuries and exposures to toxic chemicals.

The goal of this article is to present the challenges inherent to post-hurricane situations due to new types of infections and displacement of large populations and to discuss the main results of this surveillance.

MATERIALS AND POPULATIONS

The routine infectious disease surveillance relies mostly on passive reporting of certain reportable infectious dis-

ease through a web-based system and includes some active surveillance for antibiotic resistant microorganisms, influenza-like illness, and bioterrorism agents. The systems used for the routine surveillance were all web-based with data tables in New Orleans and backups in Baton Rouge. No data were lost, and the systems were functional throughout this period.

The number of people in Louisiana displaced by Katrina is estimated at 1.1 million². The routine surveillance was expected to capture confirmed reportable diseases from hospital and emergency rooms. However, under these circumstances it becomes important to monitor diseases that usually would not be reportable. To achieve this goal, a syndromic surveillance system had to be rapidly established. The targeted populations were:

- 1- Evacuees in the shelters
- 2- Residents in the affected area

The symptoms and syndromes included in the surveillance system were diarrhea and other gastro-intestinal disturbance, cough, upper respiratory tract infection syndrome, influenza-like illness, conjunctivitis, headache, rash, other skin infections, scabies-like infection, and wound infection. In the emergency room surveillance, a form detailing medical conditions and injury was completed for each patient. In the shelter surveillance, only aggregate data were collected. Denominators were the number of patient-visits at the emergency room and the number of shelter residents that day.

Any shelter cluster was rapidly investigated in order to institute the appropriate preventive measures.

RESULTS AND DISCUSSION

Reportable infectious diseases

Gastro-enteritis. One of the main concerns expressed in the media was the likelihood of large outbreaks of diarrhea and gastro-enteritis after exposure in the floodwaters (wading or swimming). Although the coliform concentrations in the New Orleans flood water were very high (average fecal coliform count 140,000 MPN / 100mL on September 3 in the Lakeview and Tulane/Gravier areas,³ these elevated fecal coliform counts are fairly typical of storm water run off. No large outbreaks of diarrhea were reported in the 2 to 4 days following exposure to floodwater. This was expected as, contrary to what happens in developing countries, large floods in the USA and other industrialized countries are usually not followed by large outbreaks of gastro-enteritis. The main reason is the rapid accessibility to safe food and water supplies.

Vibrio wound and gastro-intestinal infections. Numerous species of *Vibrios* are natural inhabitants of the sea waters. Most affected individuals have severe immune impairment or severe chronic disease, particularly liver disease. Infection occurs through ingestion of raw or undercooked seafood (particularly oysters) or contact of wounds with seawater. With brackish waters reaching into the city and coming in contact with severely sick patients, *Vibrio* infections were expected.

In hurricane free years, Louisiana has on average about thirty *Vibrio* cases per year: *Vibrio vulnificus* (~25%), *Vibrio parahaemolyticus* (~25%), other *Vibrio* species (~50% - normally including 1 *Vibrio cholerae* O1 case per year). Wound infections account for about a third of all *Vibrio vulnificus* cases.

From August 29 to October 15, sixteen cases of *Vibrio* illnesses in Louisiana residents were reported to the State Health Department (13 out of the 16 were tested in State Lab; the other 3 were tested at hospital labs). Eleven were identified as *Vibrio vulnificus* (with two fatalities), one as *Vibrio parahaemolyticus*, two as *Vibrio cholerae* Non O1 Non O139, and two as toxigenic *V. cholerae* O1 serotype Inaba biotype El Tor. Ten of the fourteen (71%) *Vibrio* cases with known onset date occurred the first week after Hurricane Katrina with eighty percent being wound-associated *V. vulnificus* infections. Fourteen out of the sixteen (88%) *Vibrio* illnesses had exposure to floodwater, one had a probable floodwater exposure, and one person became infected after stepping on a nail while cleaning his/her yard. Ten cases had wound infections, four had gastroenteritis (including a one-month-old infant exposed to floodwater), and for two cases the information on type of infection is missing.

The age of infected persons ranged from one month to eighty-nine years with a mean of fifty-seven years (mode 63 years, median 62.5 years). Eleven of the cases had a pre-existing condition; two had no pre-existing conditions; and in three the presence or absence of pre-existing conditions was unknown. Most of the *Vibrio* cases lived in Orleans Parish before the hurricanes; three were residents of Terrebonne Parish, two lived in St Bernard Parish, one in St. Tammany Parish, and one in East Baton Rouge Parish.

Toxigenic *V. cholerae* O1, serotype Inaba, biotype El Tor was isolated from a wife and husband from Terrebonne Parish. While the husband had underlying conditions and serious complications during his illness, the wife had only mild diarrhea. Both recovered well. Although the couple waded in floodwaters, it is more likely because of the incubation period that they were infected by eating boiled shrimp than being exposed to the floodwater.

Especially for Katrina, persons with pre-existing conditions (and therefore more susceptible for wound infections) had to wade, sometimes for hours, through floodwater - an exposure which is not likely to occur under normal conditions. Therefore, it is important to include the potential of wound-associated *Vibrio* infections in a hurricane disaster response plan in order to increase clinical awareness so that early and accurate diagnosis as well as appropriate treatment can be ensured in these patients. No *Vibrio*-related foodborne outbreaks were detected during the 2005 post-Hurricanes season.

Hepatitis A. The reported rate of acute hepatitis A in Louisiana has been 2 / 100,000 per year. Estimating that only 5% are reported, the real incidence rate would be 40 / 100,000, which, for a population of 1,000,000, would equal 400 cases per year. For any two-week period there would be at most 16 cases excreting viral particles in their stools (hepatitis A cases excrete viruses in their stool for one or two weeks before and for one week after the onset of illness). Knowing that a maximum of 16 people were excreting Hepatitis A virus in the greater New Orleans area, it is no surprise that there was not enough hepatitis A virus in the flood water to cause a massive outbreak. No hepatitis outbreaks were observed during the 2 months after Katrina struck.

West Nile Viral infection. During hurricanes and floods, mosquitoes are devastated and birds that did not seek refuge elsewhere are killed. Immediately following the hurricane, huge numbers of mosquitoes may breed in the floodwaters; however, these are not efficient transmitters of West Nile infection. Without a large pool of virus in the bird population, West Nile virus transmission is interrupted and it would take weeks before transmission resumes. Surveillance showed very few cases of West Nile Viral infections following these two hurricanes.

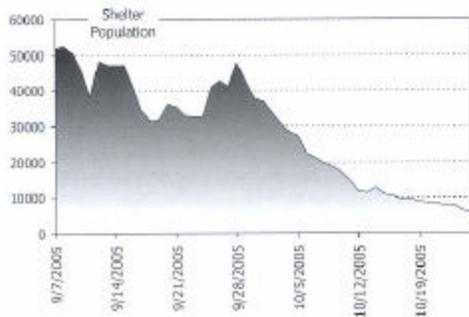


Figure 1. Shelter population during September and October 2005

Shelter surveillance

Surveillance was carried out in the shelters from September 7 to October 25. In the early days of the surveillance there were over 50,000 people living in shelters. Surveillance included mainly Red Cross shelters and large voluntary organization shelters. Small shelters were probably not included. The shelter population varied constantly, almost day to day. The denominator used for the rates was the number of evacuees that lived in the shelters reporting that day. Figure 1 presents the total shelter population (whether they reported or not). At its peak

the distribution by shelter was 7 shelters with a population >1,000, 16 shelters with a population of 500 to 999, and 381 shelters with less than 500 residents. On any day about 36% of shelters (range from 22% to 65%) participated in the surveillance program.

The incidence of main syndromes /symptoms per 100,000 per day in shelters is presented in Table 1. The most common syndrome was influenza-like illness (ILI) ranging from 16 /100,000 per day to 1,441 /100,000 per day with an average of 431 /100,000. Rash, diarrhea, and fever were the next most common.

The average incidence of diarrhea was 163 /100,000 per day which is the equivalent of 59,500 /100,000 per year or 59.5% per year. The average number of diarrheic

Table 1. Incidence of symptoms /syndromes per 100,000 per day in shelters

per 100,000	Fever	Diarrhea	Influenza-like illness	Rash	Scabies-like illness	Wound Infection	Conjunctivitis
Average	50	163	431	193	55	135	33
Minimum	15	24	16	0	0	43	0
Maximum	193	326	1441	513	683	329	101
SD	38	69	383	138	147	72	27

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episodes in the USA is quoted in several references at 1.5 to 2 /person /year.¹⁶ Therefore an incidence of 0.59 /person /year is lower than expected. Reported rates of fever and diarrhea showed a general trend toward decreasing rates with large variations from day to day (Figure 2).

Cluster/Outbreak investigations in shelters. The number and type of investigation is presented in Table 2. Eighty-one investigations were carried out, the most common being gastro-enteritis /diarrheal illness with 33 investigations. Only one of these investigations resulted in identifying an etiologic agent, which was a norovirus. The number of people involved in these outbreaks ranged from 3 to 50 with the one-third involving less than 5 people. Outbreak duration was less than 3 days.

Although influenza-like illness and upper respiratory tract infections were among the most common syndromes reported, they seldom triggered an investigation. Such syndromes were expected, and few extra preventive measures would be indicated, while for diarrheal illnesses, defining the persons affected and implementing contact isolation was deemed necessary.

Rashes and skin conditions (infection) were the third most common type of investigation. Out of seven rash outbreaks, two were large outbreaks in military populations with 37 and 40 cases. Biopsies collected on a few rash cases showed vegetable mites as the etiologic agent.

There were two conjunctivitis outbreaks, one of which involved over 200 persons. There were four incidents involving blood and body fluid exposures (needlesticks).

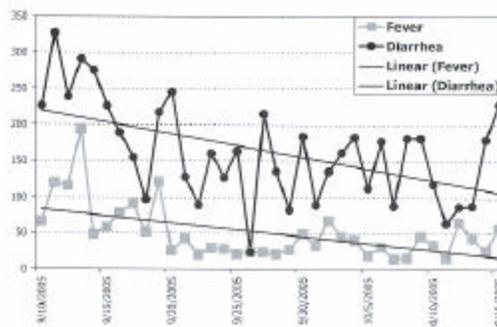


Figure 2. Trends of reported number of diarrhea and fever cases in the shelter surveillance.

Emergency Room Surveillance

The total number of emergency room visits increased to one thousand per day (Figure 3). The main reasons for the visits are presented in Table 3.

In the aftermath of a major disaster, surveillance systems need to be expanded to address the new disease conditions known to develop or perceived as being a problem. Large outbreaks of infectious diseases are known not to occur after major floods and hurricanes in industrialized nations. This was confirmed in the wake of hurricanes Katrina and Rita.

Table 2. Number of clusters investigations in shelters by week and type of investigations.

Illness Type	Total	Aug28-Sep03	Sep04-Sep10	Sep11-Sep17	Sep18-Sep24	Sep25-Oct01	Oct02-Oct08	Oct09-Oct16	Oct17-Oct23
Blood exposures	4			1	2	1			
Conjunctivitis	3		1				2		
Fever	4			1		1	1	1	
Gastroenteritis	33	8	6	5		6	4	3	1
Influenza-like	1				1				
Lice	3			1		1	1		
Rash	8		1	3	2	1		1	
Respiratory	7			2		3	2		
Scabies	3		2	1					
Skin Infection	7		4				1	1	1
TB Suspect	2		1				1		
Tetanus	1							1	
Unexplained death	2				1	1			
Upper Respiratory	1			1					
Varicella	2			1	1				
Total	81	8	15	16	7	14	12	7	2

Illness		
Gastro-intestinal	Diarrhea	597
	Nausea	1,282
	Abd pain	1,528
Fever		905
Upper Respiratory Tract		1,750
Chest	Chest pain	1,165
	Shortness breath	1,320
	Cough	2,351
	Lower respiratory tract	216
	Wheeze	183
Neurologic illness	Headache	812
	Anger	74
	Altered mentation	374
	Seizure	230
	Emotional distress	275
Musculoskeletal		1,223
Weakness		671
Rash		2,742
Hypertension		229
Total Illness		17,927
Injury		
Falls		678
Other injuries		6,196
Total Injuries		6,874

Large concentrations of people in shelters are a major concern. A surveillance system able to identify disease clusters at their onset allowed early intervention and implementation of preventive measures so that no large outbreaks occurred in crowded populations.

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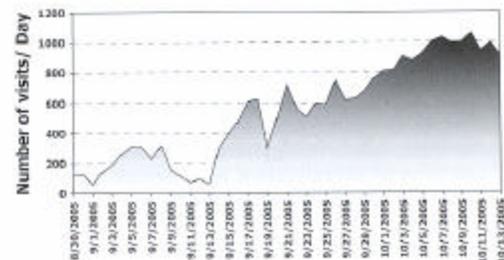


Figure 3. Number of emergency room visits tracked by the surveillance system.

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