Morbidity of Hurricane Elena

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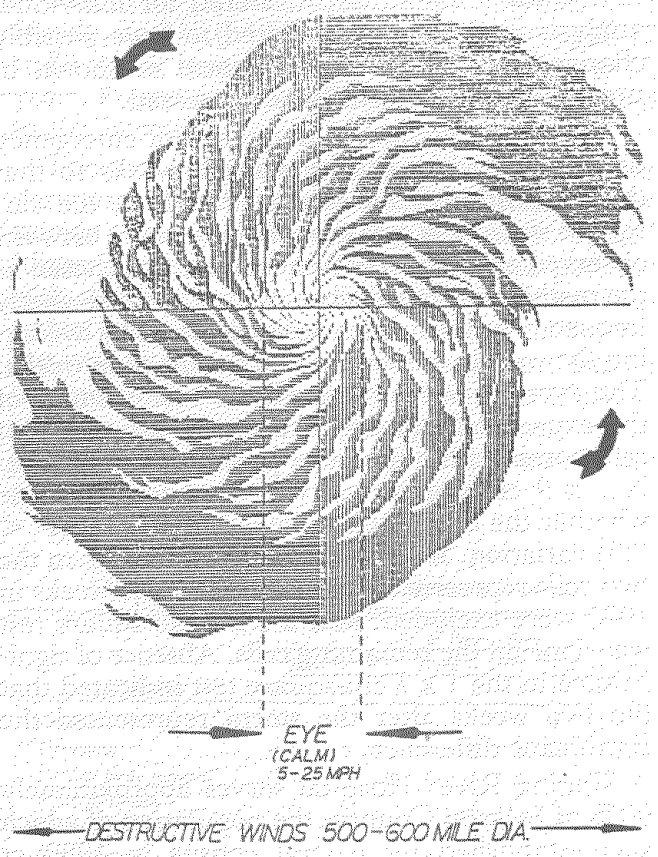
ABSTRACT: On Sept 2, 1985, Hurricane Elena struck the Gulf Coast of Mississippi. We conducted a retrospective review of Emergency Department logs for a one-week period before and a two-week period after the storm to determine what additional support would be needed to manage such a disaster. There was a significant increase in the number of patients treated for psychiatric problems and trauma. These findings are similar to the results obtained in a study at the same hospital after Hurricane Frederic in 1979.

APPROXIMATELY four hurricanes threaten the Atlantic and Gulf coasts of the United States each year. These storms have a potential for disaster, as evidenced by the Galveston storm of 1900, where 6,000 of the 38,000 inhabitants of the city lost their lives.[1] Besides loss of life, tremendous property damage and huge dislocations of people can occur. Hurricane Elena, the topic of this paper, forced some 2 million people to be evacuated.[2]

The dynamics of these storms have been described by Eliot.[3] The warm, moist air over tropical waters forms an inversion as air heated at the surface rises and meets descending cool air. Where a thunderstorm breaks through this inversion, there is an area of low pressure, which propels the prevailing winds in a spiral pattern toward its center. When winds reach 39 mph, the storm is classified as a tropical storm and is given a name; when the winds reach 74 mph, the storm is upgraded to a hurricane. Once the storm travels over land, it rapidly dissipates. The general anatomy of such a storm is shown in the Figure. These storms are huge, covering hundreds of square miles, and their severity is classified on the Saffir/Simpson Hurricane Scale (Table 1). Hurricane Elena was a class III hurricane, indicating that there were sustained winds from 111 to 130 mph, and a storm tidal surge in the center of the hurricane of nine to 12 ft.



Configuration of hurricane.

Very few studies have attempted to predict the number of patients and the nature of their complaints after a hurricane. Most studies have dealt with anecdotal descriptions,[4-6] problems with logistics and communication,[7-10] and death count.[11,12] One study addressed emotional response,[13] and another alluded to increased numbers of cases of gastroenteritis, dysentery, rheumatic fever, and pneumonia after Hurricane David in Dominica,[4] but the specific numbers of patients and the time after the hurricane that they sought treatment were not documented.

MATERIALS AND METHODS

We conducted a retrospective analysis of the

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TABLE 1. Saffir/Simpson Hurricane Scale

	Wind Velocity (mph)	Tidal Surge (ft)
I	74-95	4-5
II	96-110	6-8
III	111-130	9-12
IV	131-155	13-18
V	>155	>18

TABLE 2. Weekly Patient Census Before and After Hurricane Elena, Compared to Counts for Two Previous Years

Year	Aug 26-Sept 1	Sept 2-Sept 8	Sept 9-Sept 15	Total for Aug 26-Sept 15
1983	645	642	666	1,953
1984	586	622	656	1,864
1985	706	1,063	854	2,623

Singing River Hospital Emergency Department log for a total period of nine weeks. The intervals analyzed were the week before Hurricane Elena and the two weeks afterward in 1985 (2,623 patients total). We also analyzed corresponding three-week periods for both 1983 and 1984 (1,953 and 1,864 total patients, respectively) (Table 2). The chief complaints considered for individual analysis were those considered to have possibly changed as a result of the storm or shown in previous reports[1,5,7] to have increased.

This study compares frequency of emergency department visits during normal weeks to that during posthurricane weeks; therefore, the chi-square statistic, a measure of discrepancy between observed and expected frequencies, was chosen as the method for statistical analysis. Expected weekly frequency for each entity was calculated by averaging the weekly admission rate for the nine weeks. The average was considered the best estimate of the expected frequency if the null hypothesis of cells coming from the same population were true. A 1 x 9 chi-square test was used to determine whether the frequencies showed significant ($P < .05$) variation. If significance was found, then the two cells representing the posthurricane weeks in 1985 were excluded, and a 1 x 7 chi-square test was done on the remaining cells. Absence of significance in the 1 x 7 chi-square test indicated that the two weeks after the storm represented the significant difference.

Singing River Hospital serves approximately 90% of Jackson County, the population of which was established by federal census in 1980 at 118,015[14] people. We believe our findings are representative of the casualties that could be expected in a population of approximately 100,000 people struck by a class III hurricane. Landfall of the center of Hurricane Elena occurred approximately 30 miles to the west of our hospital.

RESULTS

There was a dramatic increase in the total number of emergency patients seen each day beginning immediately after the hurricane and lasting for approximately two weeks, with a gradual return toward the normal census afterward. The average number of visits during this 14-day posthurricane period was 137 per day, compared with the normal daily average of 92. The complaints fell into three groups. Group 1 consisted of those entities associated with a significant difference in the 1 x 9 analysis, but showing no significance in the 1 x 7 analysis (Table 3). This group, comprising those problems shown to have a significantly increased incidence due to Hurricane Elena, included stings, gastrointestinal complaints, lacerations, chain saw injuries, and psychiatric complaints. Group 2 was composed of those complaints with significant chi-square scores in both the 1 x 9 and 1 x 7 analyses (Table 4). This group had too much random variance to conclude that the hurricane caused a statistically significant difference, and included puncture wounds, orthopedic injuries, obstetric cases, and motor vehicle accidents. It should be noted that although the difference in incidence of puncture wounds and orthopedic injuries did not achieve statistical significance using the accepted P value of .05 level of significance, both would have been considered statistically significant if the .01 level had been used instead; thus, the data strongly suggest that Hurricane Elena also contributed to an increase in the incidence of these two complaints. In group 3, the 1 x 9 chi-square analysis showed no significance (Table 5), and no further evaluation was required; the complaints in this group are listed in Table 5.

DISCUSSION

The overall increase in patient visits to our Emergency Department after Hurricane Elena was due to three factors. First of all, there was an increased risk of illness and injury due to clean-up activities, lack of electricity, and potential contamination of food and water supplies. Second, the psychologic stress of anticipating and coping with the effects of the storm created a significant increase in psychiatric complaints. Finally, many local physicians were unable to open their offices for several days after the hurricane; consequently, the Emergency Department became the sole source of medical care for many patients.

In this study, a class III hurricane with landfall 30 miles west of the emergency department

TABLE 3. Complaints Showing Significant Variance

Complaint	No. of Patients Seen: Weeks in 1983* 1	2	3	Weeks in 1984 1	2	3	Weeks in 1985 1	2	3	Chi-square	P Level	Degrees of Freedom
Sting(s)	7	3	5	5	4	6	2	14	15	1 x 9 26.40	< .005	8
										1 x 7 4.00	NS	6
Gastrointestinal illness	73	61	62	49	58	64	52	87	73	1 x 9 17.22	< .05	8
										1 x 7 6.33	NS	6
Laceration	67	55	67	71	50	57	62	103	87	1 x 9 32.59	< .005	8
										1 x 7 5.64	NS	6
Psychiatric problem	8	4	3	6	6	7	13	15	13	1 x 9 17.76	< .05	8
										1 x 7 9.45	NS	6
Chain saw injury	0	1	1	0	0	0	0	13	4	1 x 9 69.58	< .005	8
										1 x 7 5.00	NS	6

*Weeks 1, 2, and 3 correspond to dates shown in column headings of Table 2
NS = not significant.

studied increased the patient load to 165% of normal (from 92 to 152 patients per day) during the first week after the hurricane, and to 133% of normal (from 92 to 122 patients per day) during the next week. Some of the complaints showing a statistically significant increase required no specific changes in staffing or equipment, eg, the number of patients with stings increased from an average of <5 per week to two per day, and gastrointestinal complaints increased from approximately nine to slightly more than 11 patients per day. The increase in lacerations, however, from eight per 24 hours in 1983 and 1984 to 14 per 24 hours in the week immediately after Hurricane Elena, combined with two chain saw injuries per 24 hours in the week after Elena, did require extra physician staffing on the afternoon shift. Chain saw injuries had importance far in excess of their actual numbers, for they required much more time to treat than other lacerations. Surgical hospital admissions did not increase after Hurricane Elena, so the specific need was for physicians capable of outpatient laceration repair. Additional nursing personnel and working space capable of supporting outpatient surgery should be allocated to an emergency department after a hurricane.

There were 28 patients treated for psychiatric illness in the two weeks after Hurricane Elena (Table 3). Eighteen (64%) of these patients were female, and 15 (54%) were young adults aged 17 to 39 years; however, ages ranged from 14 to 92 years. Fourteen of these 28 patients were admitted to the hospital.

The most common psychiatric complaint was nervousness (nine patients, 32%), followed by suicide attempts (four patients, 14%) and "upset" (three patients, 11%). There were two patients with a chief complaint of anxiety, and two with a chief complaint of depression. Each of the following was given once as a chief complaint during the two weeks after Hurricane Elena: confusion, hysteria, acute distress, hallucination, depression, anorexia, bad nerves, medicine refusal, and family problems.

TABLE 4. Complaints Showing too Much Random Variance to Attribute Significance to Hurricane

Complaint	Chi-square	P Level	Degrees of Freedom
Puncture wound	1 x 9 111.25	< .005	8
	1 x 7 14.12	.01 < P < .05	6
Orthopedic injury	1 x 9 37.33	< .005	8
	1 x 7 13.42	.01 < P < .05	6
Motor vehicle accident	1 x 9 25.15	< .01	8
	1 x 7 21.74	< .01	6
Obstetric case	1 x 9 20.00	< .02	8
	1 x 7 19.49	< .01	6

TABLE 5. Complaints Showing No Significant Variance

Complaint	No. of Patients Seen: Weeks in 1983* 1	2	3	Weeks in 1984 1	2	3	Weeks in 1985 1	2	3
Overdose	7	3	3	5	5	3	4	3	5
Drowning	0	0	1	0	0	0	0	0	0
Foreign body removal	4	6	10	6	3	5	3	6	12
Cardiac arrest	1	2	4	1	2	1	0	0	0
Dead on arrival	3	0	2	0	1	1	3	2	4
Electrocution	0	1	2	0	0	1	1	2	0
Cardiac admission	13	14	12	21	22	12	14	15	13
Surgical admission	8	6	7	5	11	4	16	10	10
Animal bite	5	0	1	2	2	3	6	4	1
Snakebite	1	0	0	2	0	1	1	1	0
Gunshot wound	1	0	5	1	0	2	2	1	0
Assault	8	4	3	9	6	6	9	9	15
Spouse assault	0	0	1	0	0	0	3	1	3
Burn	7	6	6	7	10	10	9	3	10
Eye injury	13	15	14	20	16	20	20	22	17
Left before medical assessment completed	3	1	2	2	3	4	2	7	4
Left against medical advice	3	3	3	3	7	5	1	4	4
Gasoline aspiration	0	0	0	0	0	0	0	0	0

*Weeks 1, 2, and 3 correspond to dates shown in column headings of Table 2

These findings are similar to the results obtained in a study at the same hospital after Hurricane Frederic in 1979.[15]

CONCLUSION

Hurricane Elena, a class III hurricane, placed severe added demands on our community's emergency department for at least two weeks after the storm. The greatest need was for physicians and nurses skilled in outpatient management of trauma.

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