ORIGINAL RESEARCH

Different Medical Needs Between Hurricane and Flood Victims

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Objective.—Through the review of patient records seen by the New Mexico-1 Disaster Medical Assistance Team (NM-1DMAT) after various disasters, we hoped to find patterns that might help in disaster planning. Our hypothesis was that flood and hurricane victims have different medical conditions and needs.

Methods.—We conducted a retrospective review of patient records for NM-1DMAT deployments to Hurricane Andrew in Florida (August 1992) and the Houston, TX flood caused by Tropical Storm Allison (June 2001). We compared age, gender, chief complaint, medical history, diagnosis, diagnostic testing, treatment rendered, triage category, and patient disposition.

Results.—We found several differences between the patients presenting after Hurricane Andrew and those presenting after Tropical Storm Allison. The chief complaint, diagnosis, presence of medical history, diagnostic testing, treatment rendered, triage category, and disposition all differed between the 2 disasters. The mean ages in both groups were similar.

Conclusions.—The needs of the patients differed in several areas between Hurricane Andrew and the Houston flood. This information should be tested in a future hurricane or flood and taken into account when planning for deployments.

Key words: disaster, Hurricane Andrew, Houston flood, Tropical Storm Allison, disaster planning

Introduction

Disaster planning has taken on a new importance since the attacks on the World Trade Center and the Pentagon. The New Mexico-1 Disaster Medical Assistance Team (NM-1DMAT) responded to both Hurricane Andrew in Florida and Tropical Storm Allison, which caused the Houston flood. Hurricane Andrew was a category 4 hurricane that struck the Florida coast on August 24, 1992, with winds of 145 miles per hour and gusts up to 175 miles per hour. This storm killed 41 people and caused \$20 billion in damage.¹ Tropical Storm Allison reached the Houston metropolitan area on the night of June 5, 2001, and brought heavy rains that caused a catastrophic flood. Twenty-two deaths and almost \$5 billion in damage were attributed to this storm and the subsequent flooding (Table 1).² The teams that were deployed to the disasters were composed of doctors, nurses, and Emer-

gency Medical Technicians. Although more personnel were deployed to Hurricane Andrew (68 vs 31), the composition of the teams was similar.

Mathematical models have been proposed that attempt to predict the numbers of patients and the degree to which local resources will be overwhelmed.³ Also, several papers^{4–7} have examined the needs of patients after specific disasters and their impact on local emergency departments. We believe that the best way to plan for a disaster is to learn from our past experiences. By comparing the needs and demographics of patients after different disasters, we hope to be able to develop models that will help predict patient needs and therefore help with the planning of deployments. This is the first direct comparison of 2 different disasters. The objective of this study was to determine whether flood and hurricane victims have different medical conditions and needs.

Methods

We conducted a retrospective review of patient records. All patients seen by the NM-1DMAT after Hurricane

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Table 1. Storms and demographics

	<i>Deaths</i>	<i>Cost (billions)</i>	<i>Month</i>	<i>Year</i>	<i>Population density (millions)</i>	<i>Median age in target area</i>	<i>Storm type</i>
Andrew	41	\$20	August	1992	1.94 ⁸	38.7 ⁹	Category 4 hurricane
Allison	22	\$5	June	2001	1.95 ¹⁰	32.3 ¹¹	Tropical storm/flood

Andrew and Tropical Storm Allison were included for analysis. We reviewed the patient encounter forms and established a database with the following parameters: age, gender, medical history, chief complaint, diagnosis, diagnostic testing performed (if any), treatment rendered (if any), triage code (red, yellow, green, or black), and disposition (home or hospital). Age data were analyzed by the Student's *t* test, and all other data were analyzed by the χ^2 test.

Results

After Hurricane Andrew, 712 patients were seen by the NM-1DMAT, and after Tropical Storm Allison, 578 patients were seen. The ages of the patients presenting after Hurricane Andrew were similar to those presenting after Tropical Storm Allison (mean = 33.3 vs 31.4 years; difference = 1.9 ± 2.2 years; $P = .10$). Males represented 49.3% of the patients presenting after Hurricane Andrew and 45.5% of those presenting after Tropical Storm Allison ($P = .20$). More patients had positive medical histories after Hurricane Andrew than after Tropical Storm Allison (56.9% vs 34.4%, $P < .0001$). We found a difference in chief complaints between the 2 disasters. After Hurricane Andrew, the most common complaints were wounds, musculoskeletal pain, and medication refill; after Tropical Storm Allison, the most common complaints were upper respiratory infection symptoms (which included cough, cold, sore throat, fever, and ear pain), wounds, and musculoskeletal pain (Table 2). The diagnoses were also different. Many patients presenting with upper respiratory infection symptoms were given more specific upper respiratory infection-related diagnoses (such as pharyngitis, otitis, and bronchitis). After Hurricane Andrew, 718 diagnoses were made, with the most common being wounds, musculoskeletal pain, and medication refill. After Tropical Storm Allison, 542 diagnoses were made, with the most common being wounds, musculoskeletal pain, and insect bites (Table 3). Patients after Hurricane Andrew received more diagnostic tests, with 142 patients receiving 215 tests after Hurricane Andrew and 30 patients receiving 35 tests after Tropical Storm Allison (Table 4). More patients after

Hurricane Andrew also required treatment. A total of 857 treatments were rendered to 573 patients after Hurricane Andrew, and 567 treatments were rendered to 376 patients after Tropical Storm Allison (Table 5). There was a difference in triage category as well as in disposition (Table 6); 6.3% were sent to a hospital after Hurricane Andrew, and 22.0% were sent to a hospital after Tropical Storm Allison. Not all patients had a triage category or their disposition documented; as a result, the percentages do not total 100%.

Discussion

The needs of the patients differed in several areas between Hurricane Andrew and the Houston flood. Medication refills were more common after Hurricane Andrew than after Tropical Storm Allison. More patients after Hurricane Andrew had medical histories, even though there was no significant age difference. Perhaps this is because 1) evacuation patterns differ between hurricanes and floods, and 2) hurricanes may cause more structural damage, preventing people from getting to their homes and their medications. Also, more patients had insect bites after the Houston flood, possibly due to more standing water. Patients complained of upper respiratory infections more often after Tropical Storm Allison than after Hurricane Andrew. The reason for this is unclear. It is difficult to attribute this observation to seasonal variation, as Tropical Storm Allison occurred in the spring and Hurricane Andrew in late August, and the peak incidence of colds has been reported by some to be from late August to the spring.¹³ Other sources report peaks in rhinovirus infection in September and March, April and May,¹⁴ whereas echoviruses and coxsackieviruses have peaks in the summer.¹⁵

Wounds were a very common complaint after both disasters, being the second most common complaint after Tropical Storm Allison and the most common complaint after Hurricane Andrew, likely due to more debris being present after hurricanes. In addition, much of the treatment rendered centered on wound care, with tetanus vaccinations and wound care being 2 of the 5 most common treatments after both disasters. This demonstrates

Table 2. Chief complaints: if $\geq 5\%$ of the patients had a specific chief complaint, it was included for analysis (estimate $\pm$ 95% CI)*

	<i>Wounds</i>	<i>Musculoskeletal pain</i>	<i>Medication refill</i>	<i>URI symptoms[†]</i>	<i>Rash</i>	<i>Abdominal complaints</i>	<i>Insect bites</i>
Andrew	169 (23.7% $\pm$ 3.1%)	95 (13.3% $\pm$ 2.5%)	90 (12.6% $\pm$ 2.5%)	64 (9.0% $\pm$ 2.1%)	49 (6.9% $\pm$ 1.9%)	41 (5.8% $\pm$ 1.7%)	0 (0.0%)
Allison	98 (17.0% $\pm$ 3.1%)	74 (12.8% $\pm$ 2.7%)	15 (2.6% $\pm$ 1.3%)	110 (19.0% $\pm$ 3.2%)	42 (7.3% $\pm$ 2.1%)	32 (5.5% $\pm$ 1.9%)	43 (7.4% $\pm$ 2.1%)

[†]URI indicates upper respiratory infection.

* $P < .0001$.

Table 3. Diagnoses: if a specific diagnosis was assigned $\geq 5\%$ of the time, it was included for analysis; percentages represent the total number of diagnoses made $\pm 95\%$ CI (sample size: Andrew—718, Allison—542)*

	<i>Wounds</i>	<i>Medication refill</i>	<i>Musculoskeletal pain</i>	<i>Tetanus vaccination</i>	<i>Insect bites</i>	<i>Cellulitis</i>	<i>Otitis media/externa</i>
Andrew	140 (19.5% $\pm$ 2.9%)	95 (13.2% $\pm$ 2.5%)	62 (8.6% $\pm$ 2.1%)	42 (5.8% $\pm$ 1.7%)	0 (0.0%)	0 (0.0%)	19 (2.6% $\pm$ 1.2%)
Allison	105 (19.4% $\pm$ 3.2%)	20 (3.7% $\pm$ 1.5%)	52 (9.6% $\pm$ 2.4%)	0 (0.0%)	51 (9.4% $\pm$ 2.4%)	27 (5.0% $\pm$ 1.8%)	27 (5.0% $\pm$ 1.8%)

* $P < .0001$.

Table 4. Diagnostic testing: if a diagnostic test was used $\geq 5\%$ of the time, it was included for analysis; percentages represent the total number of tests performed $\pm 95\%$ CI (sample size: Andrew—215, Allison—35)*

	<i>Urinalysis</i>	<i>Radiograph</i>	<i>Finger stick glucose</i>	<i>Complete blood cell count</i>	<i>Chem 7</i>
Andrew	49 (22.8% $\pm$ 5.6%)	48 (22.3% $\pm$ 5.6%)	37 (17.2% $\pm$ 5.0%)	26 (12.1% $\pm$ 4.4%)	15 (7.0% $\pm$ 3.4%)
Allison	8 (22.9% $\pm$ 14.0%)	7 (20.0% $\pm$ 13.3%)	17 (48.6% $\pm$ 16.6%)	0 (0.0%)	0 (0.0%)

* $P < .0001$.

Table 5. Treatment rendered: if a specific treatment was used $\geq 5\%$ of the time, it was included for analysis; percentages represent the total number of treatments rendered $\pm 95\%$ CI (sample size: Andrew—857, Allison—567)*

	<i>Tetanus vaccination</i>	<i>Wound care</i>	<i>Antibiotics</i>	<i>Pain relievers</i>	<i>Medications refilled</i>	<i>Benadryl</i>
Andrew	138 (16.1% $\pm$ 2.5%)	135 (15.8% $\pm$ 2.5%)	133 (15.5% $\pm$ 2.4%)	91 (10.6% $\pm$ 2.1%)	57 (6.7% $\pm$ 1.7%)	19 (2.2% $\pm$ 1.0%)
Allison	105 (18.5% $\pm$ 3.0%)	66 (11.6% $\pm$ 2.6%)	64 (16.6% $\pm$ 3.1%)	77 (13.6% $\pm$ 2.8%)	1 (0.2%)	29 (5.1% $\pm$ 1.8%)

* $P < .0001$.

Table 6. Triage category[†] and disposition (estimate $\pm 95\%$ CI)*

	<i>Triage category</i>			<i>Disposition</i>		
	<i>Green</i>	<i>Yellow</i>	<i>Red</i>	<i>Home</i>	<i>Hospital</i>	<i>Left without being seen</i>
Andrew	436 (61.2% $\pm$ 3.6%)	126 (17.7% $\pm$ 2.8%)	30 (4.2% $\pm$ 1.5%)	611 (85.8% $\pm$ 2.6%)	45 (6.3% $\pm$ 1.8%)	25 (3.5% $\pm$ 1.3%)
Allison	467 (79.3% $\pm$ 3.3%)	89 (15.1% $\pm$ 2.9%)	15 (2.5% $\pm$ 1.3%)	428 (74.0% $\pm$ 3.6%)	127 (22.0% $\pm$ 3.4%)	22 (3.8% $\pm$ 1.6%)

[†]Triage categories are defined as green—"walking wounded": reassess after critical patients are cared for; yellow—delayed care; and red—immediate care.

* $P < .0001$.

the need for adequate wound care supplies, including irrigation supplies, suture materials, and tetanus toxoid.

The level of acuity was low after both disasters, as evidenced by the large number of patients triaged as green and the few triaged as red and the fact that few patients were transferred to hospitals. The level of acuity was higher after Hurricane Andrew, as measured by triage category, with a higher percentage of reds after Hurricane Andrew; however, fewer patients were transferred to a hospital after Hurricane Andrew. This discrepancy is likely because of the increased availability of diagnostic testing after Hurricane Andrew. The NM-1DMAT staffed 2 sites after Hurricane Andrew; one had no capabilities for diagnostic testing, and the other was a fully equipped Urgent Care Center with laboratory and radiologic capabilities. The presence of this additional testing could have made a difference in the percentage of patients being transferred to a hospital.

There are many similarities between wilderness and disaster medicine. They are both practiced in a setting where access to definitive care is difficult or impossible and resources are severely limited. In the wilderness, this is because of the remote location in which the care is rendered. In disaster medicine, this is due to an overwhelmed health care system, either because of an increased volume of patients or because of damage to or destruction of the health care facility (or facilities).

Important differences were found in this study between Hurricane Andrew and the Houston flood. Future work should include comparisons of other past disasters. Also, these findings should be applied to future disasters to determine whether the patterns hold and the development of prediction models based on these data should proceed. These prediction models should then be applied and tested for validation. On the basis of these results, the NM-1DMAT now ensures that wound care supplies and tetanus toxoid are adequate. However, until these results are confirmed by subsequent studies, we feel that large-scale sweeping changes would be premature. To our knowledge, this study is the first direct comparison between 2 different disasters, and it uncovers intriguing differences between hurricane and flood victims. The careful study of future disasters may confirm these trends, yielding tools for disaster planners who must allocate scarce resources on the basis of predicted need.

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