

Impact of a Category-3 Hurricane on the Need for Surgical Hospital Care

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Abstract

Introduction: Hurricane Ivan, a strong category-3 hurricane, struck Grenada on 07 September 2004 and devastated the country. Grenada is a small, developing country, whose socio-economic environment and health service is typical of most countries located within the Caribbean hurricane belt. Previous reports describing the consequences of hurricanes on health-related issues have focused mainly on the experience of wealthier countries.

Objective: The objective of this study was to document the types of patients and medical problems faced by a hospital surgical service as a result of a forceful hurricane in a developing country and to help surgical divisions in developing countries prepare for strong hurricanes.

Methods: This is a retrospective study using medical records from the surgical ward of the Grenada General Hospital. Patients admitted to the surgical ward during the month following Ivan were assessed with respect to diagnosis, age, gender, and length of hospitalization. The patients admitted during the same period the previous year were used as a control group.

Results: The effects of the hurricane included a significant increase in the proportion of patients seen for diabetic feet, gunshot wounds, and infections due to wounds. The median length of the treatment time increased by 25%. In 2004, the total number of patients was 185 and in 2003, there were 167 patients admitted.

Conclusions: The results of this study indicate that preparations for future hurricanes should include securing the capacity to handle the increased needs for hospital care, and ensuring that stocks of medicines, such as insulin and antibiotics, are sufficient, properly stored, and easily available to patients (e.g., by storing medicine at hurricane shelters equipped with generators and cold storage facilities). Diabetics should be instructed to use proper footwear to reduce the risk of cuts from debris.

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Introduction

Disaster management planning currently is a topic of great interest following the wake of the forceful hurricanes hitting the West Indies and United States, as well as the Earthquake and Tsunami that struck Southeast Asia in December 2004. The objective of this study was to determine the impact of a forceful hurricane on the national surgical services of a developing nation and to identify the types of patient and medical problems that a similar surgical service can expect to face during a disaster caused by natural hazards. The effect of the Hurricane Ivan on the surgical ward of the General Hospital in Grenada was investigated. The differences were examined among the patients that were admitted to the surgical ward in the month following Ivan and those normally admitted to the surgical ward during "normal" times.

The State of Grenada is an island located in the Caribbean Sea with an area of 344 km² and a population of 89,357 (July 2004 estimate).¹ Previous reports that have described the effects of hurricanes on health facilities and health problems have focused mainly on developed countries that have more

resources with which they are able to respond to disasters. In contrast, this study evaluated the effects of a hurricane on a small, developing country similar to many countries located within the hurricane belt. The results from this study hopefully can be useful in preparation for future hurricanes.

Hazard

Every hurricane season, the nations in the Caribbean are struck by hurricanes and tropical storms, resulting in damages to the economy and the health of the people. The countries generally are small islands that are economically vulnerable and have limited resources, which restrict evacuation possibilities. Many of the communities are located on the coast, making them vulnerable to storm surge.

Event

On Tuesday, 07 September 2004, Hurricane Ivan struck the small country of Grenada and resulted in extensive damage. Ivan struck Grenada as a strong category-3 hurricane on the Saffir-Simpson Scale (grading hurricane force from 1 to 5, 1 being the weakest and 5 the strongest). The sustained wind speed was >193 km/hr (120 mph) with gusts reaching a maximum wind speed of 233 km/hr (145 mph). A comparison of the rainfall received during the hurricane to normal seasonal rainfall rates indicates that relatively little rain fell during this event.²

Damage

Health and Healthcare Facilities—Thirty-nine people were killed as a result of the hurricane.³ Within two weeks after the passage of Hurricane Ivan, the Accident and Emergency Departments of the two largest hospitals reported that 680 persons had been treated for various injuries. The damage to the public hospitals, health centers, and other healthcare institutions has been estimated at EC\$11 million East Caribbean dollars (approximately US\$4 million) following the aftermath of Hurricane Ivan. The medical laboratory at Grenada General Hospital suffered the worst damage within the hospital compound; the laboratory lost approximately 40% of its roof, which subsequently caused severe damage to the equipment.²

Infrastructure and Economic Sectors—Immediately following the event, the entire population was without access to electricity—except the few who had personal generators—and almost the entire population was without access to potable water. Eighty-nine percent of housing was damaged or destroyed. Two weeks after the hurricane, there still were 4,000 tons of galvanized roofs and almost a million cubic meters of debris spread over the country. Ninety-one percent of the forestlands and watershed were stripped of vegetation. Trees and debris blocked the roads, causing difficulties in transportation of relief goods.²

The main sectors in the Grenadian economy are agriculture and tourism. The most important crop is nutmeg, which employs approximately 30,720 persons directly or indirectly.² Eighty percent of the nutmeg plantations were ruined by the hurricane. This is especially unfortunate given that a nutmeg tree requires more than five years to

mature and bear fruit.⁴ In the tourism industry, >60% of jobs were lost.³

Safety—Looting started immediately after the impact of Hurricane Ivan. The prison was damaged by the hurricane and the prisoners escaped. The police experienced difficulties restoring order, and eventually, troops from Trinidad and Tobago and other Caribbean nations were brought in.³

In summary, this was the most devastating disaster that has affected Grenada with the total damage estimated to be EC\$2.4 billion (approximately US\$0.9 billion), more than twice the value of the gross domestic product (GDP) of the country.²

Methods

This was a retrospective study using medical records from the surgery ward of Grenada General Hospital, which is the main hospital in Grenada and has 200 beds. It is the only public health facility in the country that provides surgical hospital care. All patients admitted to the surgical ward in the month following Hurricane Ivan (07 September 2004 to 07 October 2004) were classified as the Assessment Group. As a Control Group, the records of patients admitted during the same period the previous year were used. The parameters examined were gender, age, length of hospitalization, and diagnosis. The patients were classified into seven groups based on their primary diagnosis: (1) intra-abdominal diagnoses (appendicitis, cholelithiasis, hernia, urinary retention, renal colic, etc.); (2) blunt trauma (fracture, concussion, etc.); (3) lacerations; (4) infections due to wounds; (5) diabetic foot; (6) gunshot wounds; and (7) other causes.

The age and length of hospitalization data were processed using the Mann-Whitney *U*-test. The diagnostic data and gender differences were processed using the χ^2 test. The differences were considered significant if $p \leq 0.05$.

Results

The number of patients admitted in 2003 was 167 and 185 in 2004—a 10.8% increase in the number of admissions. The Assessment Group consisted of a total of 185 patients; 60 females and 125 males. The Control Group consisted of 167 patients; 58 females and 109 males.

Length of Hospitalization

The overall length of hospitalization was significantly longer in 2004 than in 2003, with a 25% increase in median treatment time ($p = 0.0014$). The median treatment time was five and four days, respectively. For each individual diagnosis group, the time spent in the hospital was longer in 2004 (Table 1), but only was significantly longer for patients with lacerations ($p = 0.0236$), with a median stay of seven days in 2004 and two days in 2003. Overall, diabetic foot problems had the longest treatment times in 2003 and 2004.

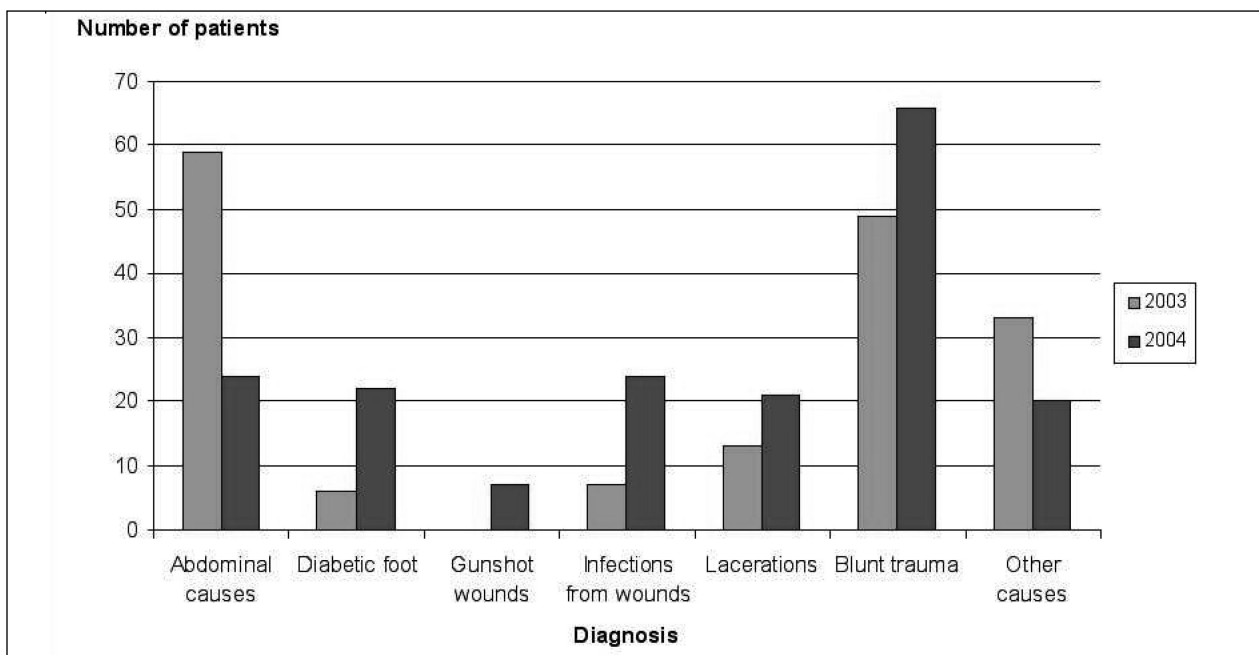
Age

The median age of the patients from year 2004 was 39.0 years, slightly higher than that of the patients of year 2003, 35.5 years. However, this difference is not statistically significant ($p = 0.2854$).

Diagnosis Group	Treatment time 2003 Median number of days	Treatment time 2004 Median number of days
Abdominal causes	3	5
Diabetic foot	12.5	21
Gunshot wounds	--	2
Infections from wounds	6	8
Laceration	2	7
Blunt trauma	4	4
Other causes	4	4

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Table 1—Length of hospitalization. Median length of hospitalization in 2003 and in 2004 for each diagnosis group



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Figure 1—Number of patients in each diagnosis group in 2003 and 2004

Diagnosis

A statistically significant increase was found in the proportion of patients evaluated for diabetic foot ($p = 0.0074$), gunshot wounds ($p = 0.0310$), and infections originating from wounds ($p = 0.0066$) in 2004 (Figure 1). Diabetic feet increased from 3.6% of the patients to 11.9%, gunshot wounds from 0%–3.8%, and infections from wounds from 4.2%–13.0%. Abdominal symptoms and other symptoms decreased significantly in 2004 ($p < 0.0001$ and $p = 0.0281$). There was an increase in the number of patients who sustained blunt trauma and lacerations in 2004, but the difference was not statistically significant.

Gender

There was no significant difference in the proportion of the total number of female patients and male patients between the two groups. When looking at each gender separately (Table 2), the increases in diabetic foot was significant

among females ($p = 0.0189$), but not among males ($p = 0.2144$), and the increase in infections from wounds was significant among males ($p = 0.0038$), but not among females ($p = 0.6007$). Among both females and males, the decrease in abdominal symptoms for hospitalization was significant (females $p = 0.0028$, males $p = 0.0003$). The patients with gunshot wounds were all males 16–36 years of age. Diabetic foot was equally common among females and males in 2003, but in 2004, there was a significant ($p = 0.0092$) difference in the proportion, with women comprising the majority.

Discussion

The Grenada General Hospital, particularly the laboratory, suffered from severe damages caused by Hurricane Ivan. This should be taken into consideration when reviewing the results, since the damage to the laboratory was a hindrance to the efficient management of patients (e.g., when determining therapeutic end points in the treatment of dia-

Diagnosis	Females 2003	Females 2004	Males 2003	Males 2004
Abdominal causes	20	6	39	18
Diabetic foot	3	13	3	9
Gunshot wounds	0	0	0	7
Infection from wounds	5	8	2	16
Laceration	3	8	10	13
Blunt trauma	12	16	37	50
Other causes	15	9	18	11

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Table 2—Number of patients in each diagnosis group separated with respect to gender and year

betes). The comparison between the number of patients admitted in 2003 and 2004 indicates an increase of 10.8%. However, this number has not been stable over time. In 2002, 178 patients were admitted each month in September and October, which indicates that the hurricane did not have a great effect on the number of patients admitted. However, due to constraints on resources and the increased emergency workload, all planned, non-emergency admissions were cancelled after the hurricane. The statistics for the study period reflect emergency admissions only, while those for the control period are a combination of emergency and non-emergency admissions, thus underestimating the measured effect of the hurricane.

The increase in problems associated with diabetic foot could have several causes. The destruction of roads made it difficult to reach medical facilities and the lack of electricity made proper storage of insulin at home impossible. Therefore, it is likely that many diabetic patients did not have access to insulin after the hurricane, and thus, experienced poor metabolic control. Being a victim of a hurricane causes psychological stress. Stress increases the blood sugar level, thus causing poor glucose control in many diabetic patients, particularly patients with Type-2 diabetes.⁵ Inui *et al* examined the relation between the HbA1c levels of diabetic patients and stress due to the life-threatening experiences of the victims of the Kobe earthquake in 1995; the glycemic control in diabetic patients was negatively affected by their experience in a disaster caused by a natural hazard.⁶ Sengul *et al* confirmed the negative effects of a disaster caused by natural hazards on metabolic control in diabetic patients, and found an increase in HbA1c-levels and insulin requirement.⁷ Inui *et al* also compared the HbA1c-levels of the patients of Kobe to the HbA1c-levels of patients residing in Osaka, which was struck by an earthquake of lesser magnitude.⁶ The level of stress and the HbA1c-level are positively correlated to the level of devastation caused by the disaster. Patients who had experienced severe damage to their house or had relatives that had been injured or killed showed higher stress levels and worse metabolic control. In Grenada, Hurricane Ivan damaged

the vast majority of the houses. It is likely that the increase in diabetic foot problems was caused by poor metabolic control, partially as a result of the stresses of a life-threatening experience, such as the hurricane and the devastation that resulted.

Previous studies have shown that wounds and infections are common after a hurricane.⁸⁻¹⁰ These findings were reflected in this study as an increase in infections due to wounds and an increase in diabetic foot problems. Most injuries occur after a hurricane, during the clean-up of debris and not during the hurricane itself.⁸ The increase in infected wounds and diabetic foot in this study probably is linked to injuries caused by the vast amount of galvanized roof and other debris scattered across the country after the hurricane.

Gunshot wounds were non-existent in the Control Group, but in the month following the hurricane, seven patients with gunshot wounds were treated on the surgical ward, possibly indicating an increase in violence due to the effects of the hurricane. An increase in violence in the aftermath of hurricanes corroborates with other reports. The Dade County Medical Examiner Department in Miami, Florida, reported that homicide/suicide deaths doubled in rate for the six months following Hurricane Andrew.¹¹ Keenan *et al* showed an increase in inflicted traumatic brain injury among children after Hurricane Floyd struck North Carolina.¹² Counties less affected or unaffected by the event showed no corresponding increased incidence.

The length of hospitalization was significantly longer in 2004 than in 2003. This likely was due to the differences in the diagnoses between the two years, since there was no significant difference in treatment time for each diagnosis between the two years, apart from lacerations, which had a significantly longer treatment time in 2004.

Limitations

This was a retrospective study. Therefore, there were variations in the reporting of the medical conditions in the medical records due to the severe and difficult conditions after the event. Some of the medical records for the patients had missing data elements and for some, medical

conditions were reported in a way that was not optimal with respect to the data collection. For example, the medical records of patients with multiple diagnoses only may have had the primary component reported, preventing a full analysis in the present study. Future studies with more data on the circumstances for individual cases are encouraged in order to validate the findings of this study. It also would be interesting to examine the reasons behind the gender differences in some of the patient groups.

Conclusions

The effects of the hurricane included increased hospitalization time and different diagnoses of admitted patients. The increase in diabetic foot problems and infections from wounds indicated that in preparation for hurricanes, it is important to ensure that stocks of medicine, such as insulin and antibiotics, are sufficiently and properly stored. Hospitals also should be prepared for an increase in weapon-related injuries. The results of this study indicate that a hurricane causes an increase in need for hospital care due to an

increased number of patients, and longer hospital stays. Hospitals must address the issue of how to meet this demand. Since the devastation of infrastructure after a forceful hurricane can be severe, it is important to arrange for medicines such as insulin to be stored at hospitals and in places more accessible to the patients, for example, hurricane shelters. These places must be equipped with generators to ensure access to electricity to enable proper storage. If cold storage facilities close to the patients are available, they can bring their insulin and have their medicine properly stored. In order to decrease the risk of diabetic foot complications, diabetic patients should be advised to bring their medication to the shelter, and to wear proper footwear to avoid risking cuts from debris when walking.

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