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Original Article

Tropical cyclone Fani—perspective from the trauma and emergency department of an affected tertiary hospital

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ABSTRACT

Purpose: To explore the epidemiological and clinical profile of patients admitted to the trauma and emergency department (TED) of a tertiary care hospital due to tropical cyclone Fani and highlight the challenges faced by the hospital in this natural disaster.

Methods: A retrospective study was conducted in the TED in the affected zone. Data of all victims affected by the cyclone Fani on May 3, 2019 were obtained from disaster records and medical case sheets. All patients except death on admission were included. Clinical variables included anatomical sites and severity of injuries which was assessed by revised trauma score (RTS) and injury severity score (ISS). Trauma injury severity score (TRISS) was also calculated.

Results: Of 75 patients, 74 were included and the other one was brought dead and thus excluded. The age, median ± interquartile range (IQ), was 41.0 (27.7–53.0) years. The male to female ratio was 2:1. Most of the wounded were transported by the police control room vans on day 1: first 10 h, 50.0%; 10-24 h, 20.3%. The median ± IQ range of RTS, ISS and TRISS were 20 (14–28), 7.84 (7.841–7.841), and 97.4 (91.6–98.9), respectively. Simple external injury was the dominant injury type. Polytrauma (ISS >15) was seen in 67% cases and spine injury in 14% cases (7% cervical and 7% thoracolumbar). Injury causes included sharp flying objects (broken pieces of glasses and asbestos) in 31% cases, followed by fall of trees in 20.3%. Twenty-four patients were discharged after primary treatment, 30 admitted to the indoor-trauma ward or intensive care unit and 20 deferred or transferred to another center. There was no in-house mortality. Challenges were related to electricity failure, mobile network breakdown, infrastructure collapse, and delay in expertise repair from outside due to airport/railway closure.

Conclusion: In cyclonic storm like Fani, sharp flying objects, fall of trees/poles and collapsing walls constitute the common mode of injuries causing harm to more than one body regions. Polytrauma was seen in the majority of patients though external injury was the commonest. The affected hospital had the uphill task of treating hospitalized patients as well as disaster victims.

Introduction

The world has witnessed nature's fury in form of disasters with more than 2.6 billion people affected in the last decade itself.[1] The disaster report (2015) states that Asia accounts for half (48%) of global disaster burden; but it turns as a whopping rate as 86% based on population, both in terms of affection and mortality.[2] Earthquakes, cyclones, landslides, floods, and extreme weather fluctuations such as heat waves and severe cold weather cause a significant casualty in almost all countries. Acute disaster casualties exemplified by number, severity and diversity of injuries can exhaust the capacity of existing medical resources to deliver comprehensive medical care.

The sufferers not only abide by immediate injuries such as blunt trauma, crush-related injuries, drowning injuries but also harness long-term mental health issues. Although, trauma and wounds are the utmost priority of management, there are other aspects of non-

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related routine emergencies such as the maternal & child care and mental health issues that co-exist in these tense situations.[1]

The East Indian peninsula is regularly ravaged by the high velocity cyclones such as “super-cyclones”. Odisha, for example, a costal state located in East India, has witnessed the past “super-cyclone” in 1999 which claimed more than 10,000 lives.[3] Better planning and preparedness by both government and various non-government organizations reduced the consequences of another cyclone “Phalin” in 2013 to less fatality of humans and other livestocks.[4]

Recently, Odisha coast was stormed by the cyclone Fani (May 2019).[5] Following the aftermath, many challenges have been thrown particularly to the health workers who are serving in the affected zone. Thus, we aim to analyze the spectrum of patients coming to us and discuss the unique problems faced in a tertiary care center that itself was in midst of nature wrath.

Methods

Study design and settings

This is a retrospective study conducted in the trauma and emergency department (TED) of a premier tertiary medical hospital in the zone of cyclone affection.

Study population

Data of all trauma patients visiting TED due to the cyclone Fani on May 3, 2019 were obtained from disaster records and medical case sheets from medical record department. Permission was obtained from the institutional research & ethical committee for waiver. All patients were included except those having inadequate data or brought dead. The demographic variables like age, sex, time of injury, time to reach the TED, mode of transport to the TED and injury mechanisms were recorded.

Clinical variables

The clinical variables like pulse rate, blood pressure, respiratory rate, anatomical site and severity of injuries were noted. The trauma scores, namely revised trauma score (RTS), injury severity score (ISS) and trauma injury severity score (TRISS) were calculated. The site of injury was noted from systemic examinations performed and radiological reports like X-ray, computed tomography (CT) and focused assessment with sonography for trauma (FAST) scan.

Outcome measures

The procedures performed on patients in TED and any operations were recorded. Outcome of patients were grouped as discharge, admission to indoor-trauma ward or intensive care unit (ICU), or referral. The early mortality (<24 h) was also documented. Various issues and challenges faced during this period were recorded from staffs of TED and resident doctors.

Statistical analysis

All data were entered in Microsoft Excel sheet and imported for analysis to statistical package for social sciences (SPSS, IBM, USA) version 20.0. The analysis was done using descriptive statistics. Categorical data were calculated in terms of proportion and percentages whereas numerical data (non-parametric) were measured in terms of median and interquartile (IQ) range.

Results

A total of 75 patients came to our center. We retrieved data of all of them. One patient was brought dead and thus excluded. Hence, altogether 74 patients were included in this study and there was no data loss. The detailed flow diagram of patients was shown in Fig. 1.

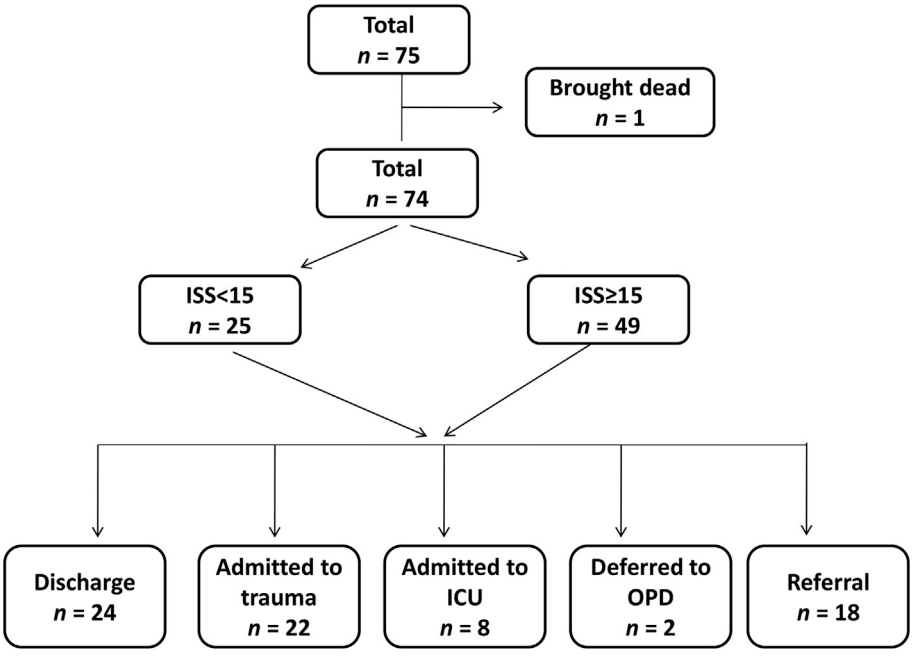

Fig. 1. Flow diagram of the 75 patients present to emergency department after tropical cyclone Fani. ISS: injury severity score; ICU: intensive care unit; OPD: outpatient department.

There were 49 male (66.2%) and 25 female (33.8%). The median age ± IQ was 41.0 (27.7–53.0) years. The 41–55 years group was mostly affected, accounting for almost half of them (42 cases) (Table 1). Most patients (52/74, 70.3%) were transported by the police control room (PCR) van in 24 h (first 10 h, 50.0%; 10–24 h, 20.3%). Polytrauma was seen in most patients (Table 1).

The median ± IQ of ISS, RTS and TRISS was 20 (14–28), 7.841 (7.841–7.841), 97.4 (91.6–98.9) respectively. Even though simple external (soft tissue) injury was the most common injury, polytrauma (ISS >15) was seen in 67.5% cases. Spinal injury occurred in 13.5% patients, including 6.7% cervical and 6.7% thoraco-lumbar. The detailed injury regions are shown in Fig. 2.

The mechanism of injury is depicted in Fig. 3. Sharp flying object was the dominant cause of injuries, 31.2% by broken pieces of glasses and 20.3% by asbestos. Hit by fall of trees, walls, electric poles and other heavy objects was another common injury mechanism, mainly causing spine injuries. The only patient who arrived dead was due to cervical spine (C_{4-5}) injury due to fall of wall.

Table 1
Distribution of frequency and percentage among various variables.

Variable	*n* (%)
Age (years)	
<10	3 (4.1)
10–25	14 (18.9)
26–40	20 (27.0)
41–55	31 (41.9)
>55	6 (8.1)
Transport mode	
108 Ambulance	20 (27.0)
Hospital ambulance	1 (1.4)
Police control room van	17 (23.0)
Private ambulance	19 (25.7)
Private vehicle	15 (20.3)
Self	2 (2.7)
Arrival time (h)	
<1	4 (5.4)
1–10	33 (44.6)
10–24	15 (20.3)
>24	22 (29.7)
Total body regions injured	
1	33 (44.6)
2	20 (27.0)
3	10 (13.5)
>3	11 (14.9)

Fifty-six (75.7%) patients were treated in the hospital itself whereas 18 (24.2%) were referred to other centers (Fig. 1). In the TED, suturing and dressing was the most common procedure followed by splintage & slab for fractures. Chest tube was inserted in 10 patients with blunt pneumothorax and/or hemothorax trauma. Rapid sequence intubation was performed on 4 patients. Closed orthopedic and maxillofacial injury patients were sent home with slab for later review at the outdoor patient department or referred to other centers. There was no early in-house mortality.

Discussion

Fani is a category IV tropical cyclone that affected the Odisha coast on May 3, 2019 at about 8:30 till 14:00 with landfall in Puri.[6] Its origin was a tropical depression in the west of Sumatra in the Indian Ocean on April 26, 2019. Soon it gained intensity and momentum to an extremely severe cyclonic storm—comparable to category 4 hurricane (categories 1–5 based on the Saffir-Simpson Hurricane Wind Scale).[7] Massive evacuation of 1.2 million people prevented the mortality to bare minimum: total death toll of 72, of which 64 were in Odisha.[8] The strong winds with a speed reaching 250 km/h accompanied with rainfall caused severe loss of properties and flora.[7] Berg[9] reported that hurricanes are massive destroyers of property and human health as wind speeds reach ≥155 mph.

The Indian Meteorological Department forms an important warning center of the North Indian basin, both for tracking and issuing bulletins, warnings, and advisories about tropical cyclones in this subcontinent.[5] People were injured directly by the collapsing infrastructure (fall of wall/trees) and/or hit by sharp flying objects including glass fragments and other objects. We are a 900 plus bedded hospital with the occupancy rate of more than 90% anytime. The challenge looming was not only management of the in-house patients, but to provide immediate emergency and trauma care to the disaster victims.

Problems and challenges

We are also affected by the cyclone ourselves. There was a huge loss of the infrastructure and building, which is yet to be officially

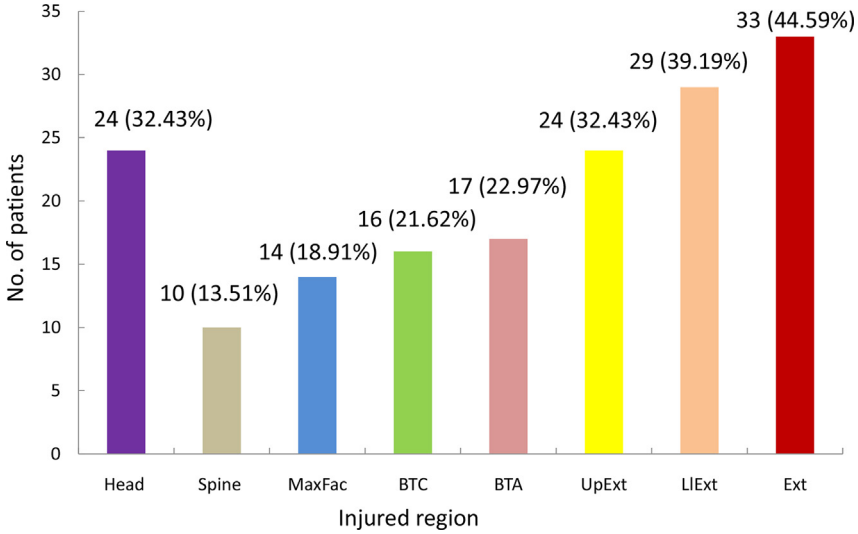

Fig. 2. Bar diagram depicting patterns of the 75 patients in tropical cyclone Fani. MaxFac: Maxillo-facila; BTC: blunt trauma chest; BTA: blunat trauma abdomen; UpExt: upper extremity; LlExt: lower limb extremity; Ext: External.

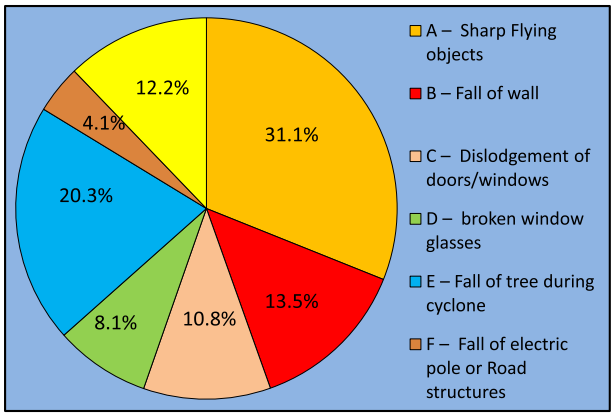

Fig. 3. Frequency distribution of mode of injury of the 75 patients in tropical cyclone Fani.

declared. The problems and challenges were numerous as we had an uphill task of saving our hospitalized patients.

The immediate effect of the storm was a total blackout with complete shutdown of electricity. The generator supported the ICU and operating theaters (OTs) only. The government restored the power supply for hospitals by the next 24 h. Some of the high-end medical equipment about diagnostic services, including the laboratory and radiological facilities (digital X-ray, CT, magnetic resonance imaging) were shut down, due to failure of the central air-conditioning plant. This was due to electricity failure and damage because of the fall of the chimney of the burner on the air-conditioning unit (Fig. 4A and 4B). The portable X-ray was working, and CT was the next priority for emergency services. Portable ultrasonography needed for FAST in TED was also employed. Because the medical gas pipeline system has been severely ravaged by the strong winds, as depicted in Fig. 4C, the supply of oxygen to critical areas like OTs and ICUs was affected. As a result, the TED was spared of sudden interruption of oxygen supply as it has an independent gas manifold. This was utilized to shift immediately some patient on ventilators from ICU to TED. We were largely dependent on the stored oxygen cylinders that were rushed to the above critical areas. The water supply was limited for up to 4 days initially, which affected the routine functions of OTs. Hence, we were compelled to cancel the elective OTs for 4 days until the storage was filled up and repair process started.

During the period of cyclone, the doors of TED has been closed, bolted and jammed with heavy movable furniture to prevent forceful opening as displayed in Fig. 5A and 5B. Yet there was breakage of the glass panes and scattering all over the red and yellow zone of TED, making transportation difficult and risky. The false ceiling collapsed at several places, including the TED (Fig. 5C–E) and affecting patient movement.

The hospital electronic patient information system was collapsed with the communication black out of all mobiles and internet services. The patient registration was done manually. Doctors on duty were sitting round the clock due to inability to communicate as mobile failure and there were problems in getting expert opinion from other departments, which had to be contacted by errand messengers. For the first 2 days, we felt as if we had been brought back to an era 30 years back in our country. The mobile services in city were partially restored by 12 h and gradually by day 2, when our hospital-based mobiles became active.

From the patent's perspective, they faced problems in contacting with the 108 Ambulance services due to failure in network communication. We could use some of the 108 Ambulance for referral when they came to drop in patients in addition to our own ambulance services. There was obstruction on major roads and unavailability of private vehicles in pre-hospital transport. All major petrol pumps were working but had long queue due to chaos and uncertainty looming large. The memories of last super cyclone (1999) had been refreshed in minds of public wherein the state crisis lasted for more than a month. Hence, this disarray was expected. The entry to the city like airports and railway station was also crippled for the first 2–3 days (Fig. 6) which hampered the import of high-level technical support for the restoration of cooling unit and machinery power. Besides all struggles, the main work force (medics and paramedics) suffered with personal agony both at home and work place in this odd hour. Food was provided by canteen services on day 1; but most hotels took 3–4 days to restore catering services.

Epidemiological and clinical data

We have no previous data regarding injury patterns following tropical cyclone. This may be due to the lack of a patient surveillance form as developed by Centers for Disease Control and Prevention (CDC) in the Unites States after the hurricane Katrina.[10] The number of deaths reported though is much less compared to cyclone with similar or less wind speed.[10–12] This is attributed to modern forecasting systems and better preparedness by the state which is used to cyclone-hits regularly in short spans. More than 2.6 million text messages, television media, radio broadcast, sirens and various other public-redress systems were utilized to caution the people and appeal to move to 9000 shelter homes with kitchens.[13,14]

Males were more affected than females (almost 2:1) and this is logical as males were more outdoors on the fateful day. People of all age groups were affected with 41–55 years more frequent. Injuries due to sharp flying objects such as glass pieces and asbestos

Fig. 4. (A) Broken chimney of boiling unit which fell on the medical gas pipeline system and central air conditioner coolant, causing damage to both; (B) Close view of the broken chimney parts (black arrow); (C) Disruption of medical gas pipelines (blue arrow).

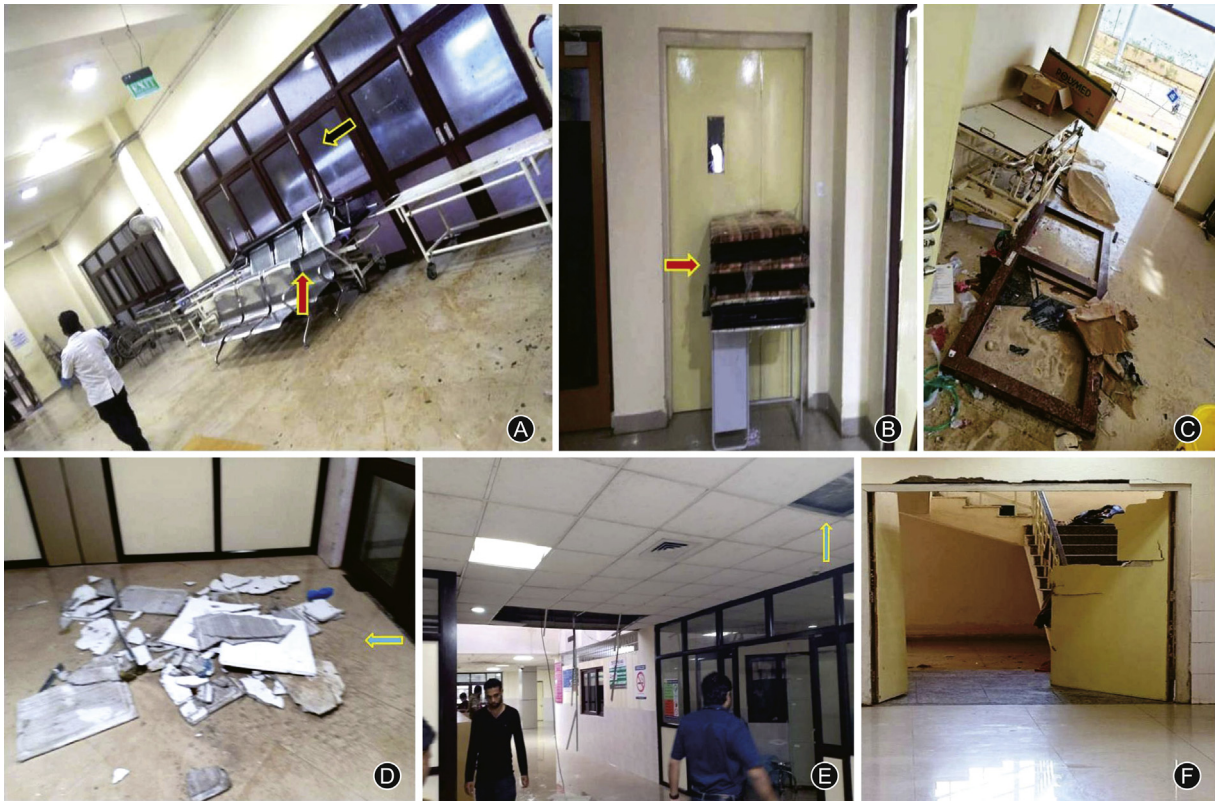

Fig. 5. (A and B) TED entrance for patient being blocked by heavy furniture (red arrow); (C) On the backside, black arrow shows the ambulance waiting to shift the patient safely to the ED during the peak period of cyclone; (D and E) damage to ED like fall of false ceiling; (F) Damage the back-doors of TED. TED: trauma and emergency department; ED: emergency department.

Fig. 6. Massive damage to the railway station and airport. Source of figures: Agency France Press and Asian News International.

sheet were the commonest mechanism of injury, followed by falling trees and collapsing walls. People inside house were most commonly injured by broken glass pieces and trapping of body parts due to strong wind. This is unlike the floods where drowning or the earthquakes where fall of debris remains the common causes.[15]

The first patient received during the cyclone was a nine-year-old girl 45 min after head injury due to flying piece of asbestos. During the first 10 h, most patients were brought to the emergency by PCR vehicle, which has been deployed for patrolling to carry patients. Lack of mobile network made contact with 108 Ambulances difficult, which remained parked in peripheral hospitals where the patient reached and were later referred to our set up. Roy et al.[15] found in their study that transportation was carried out by the injured themselves via private vehicles. In our case, the advanced weather forecast had led to state preparedness unlike the unseen tragedy of Gujarat earthquake. The transportation time for patients to our hospital was maximally 2 h even though the distance was 60 km radius, which was much less than the time in Gujarat disaster. Though most of the patients arrived within 10 h, the delay was more due to the fear to travel and failure of 108 Ambulance communication. In our case, PCR van was the first rescuers. Shoaf et al.[16] have noted that in disasters, private cars are the first vehicles to reach the “buffer zone hospitals”. This is due to well-inform and more affluent patients unlike ours where rapid and timely government response alerted the people of all sections and quick PCR monitoring post-math to rescue affected persons for civil and medical purpose.

Polytrauma (ISS>15) accounted for most patients (49 cases, 66.2%) received in the emergency room. Soft tissue injuries were the most frequent injury pattern, followed by extremity trauma and head injuries. Noe et al.[11] also found lacerations/cuts (63%) as common injury patterns after hurricanes Gustav and Ike. This is different in injury mechanisms from other natural calamities like the earthquakes where most injuries are due to trapping of extremities or jumping out of the buildings.[17]

Of the 74 patients triaged and treated, one third could be fully treated and discharged, a little more than that admitted for surgery, and the rest were referred to other centers. Steinman et al.[18] advocate for "less in more" during times of disaster, i.e. extending limited resources for care of the maximum number of sufferers than investing individuals. The triage principle segregates patients with limb threatening injuries and infections to be managed as the highest priority and the same principle was executed in our hospital. Eighteen patients were referred from our hospital after initial stabilization, which was due to disruption of the medical gas pipeline system, leading to limited oxygen supply in ICU and emergency OTs, which rely on H-type oxygen cylinders. Five cases of cervical spine injuries were included in those referred patients who may require prolonged postoperative ICU care.

In a disaster situation, overcrowding compromises asepsis, leading to a usual higher post-operative infection rate and morbidity.[15] External fixation which forms the basis of damage control in orthopedics is the approach of choice in polytrauma and compound wounds.[19,20] The closed and isolated factures were best deferred after putting a slab to return to the out-patient department after 3–5 days for routine (more sterile) theater.

In our study, early mortality rate (i.e. within 2 weeks) among hospitalized patient was nil. Thapa et al.[17] reported a mortality rate of 2.6% (13/493). Another study by Giri et al.[21] found that the 90 days mortality for hospitalized earthquake victims was as low as 2%. The major cause for immediate mortality (within 24 h) is crush injury for earthquake victims. Regarding Fani in this study, the government issued timely warning to caution people to stay indoors in concrete houses and the poorer were shifted to makeshift shelter homes leading to less severe injuries and casualties and overall death as well. The preliminary report says the death is 72, which may be initial count.[8] The death toll in Puerto Rico due to hurricane Maria was initially documented as 64 by Puerto Rican government authorities but several other reports found a much higher estimates between 1400 and 5740 deaths.[12]

We do have certain limitations. This is a single center study (only public tertiary care) in the eye of cyclone where maximum patients have visited. There are other hospitals in the city that were affected by the Fani, where few disaster patients have visited. Thus, actual number of victims may be much more. We also apprehend that the problems in transportation during initial hours of days 0 & 1, the number of trauma patients received to our emergency may be less than anticipated. Due to lack of mortality and morbidity surveillance forms developed elsewhere, we had to rely on the disaster records of hospital. The long-term outcomes of patient and sequelae such metal health issues were not surveyed in our audit of patients.

In conclusion, tropical cyclones like Fani pose a huge challenge to the health care facilities and work force to mitigate and manage the health disruptions and restore functional normalcy especially who are serving the affected zone. Future studies that evaluate the long-term health consequences of such natural calamities are warranted to document their overall health impact in terms of mortality and morbidity.

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Nil.

Ethical Statement

Permission has been obtained from the Institutional Research & Ethical Committee for waiver.

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Declaration of Competing Interest

The authors declared no competing interest.

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