

ORIGINAL RESEARCH

Profile of Injuries and Conditions Treated in a Rural, Temporary Emergency Site Following an EF-4 Tornado

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Abstract:

Background

On April 28, 2014, an EF-4 tornado struck the town of Louisville, Mississippi. The local, rural hospital was damaged to the point of closure and 10 people were killed. A temporary, mobile emergency site was established, but little data was available to guide the expected patient population and clinical needs. Our objective was to perform a descriptive analysis of patients who were treated in a rural, temporary emergency care site in the immediate aftermath of a tornado.

Methods

A retrospective chart review was performed of all patients seen at the temporary emergency site in the immediate aftermath of the tornado. Patient charts were reviewed for patient demographics, diagnosis, and disposition. Diagnoses were categorized into categories and subcategories for review. Descriptive statistics were utilized as indicated.

Results

A total of 323 patients were seen from April 29, 2014 to May 17, 2014. The average age was 39.6 years, with 17% pediatric and 83% adult patients. The majority of patients (88%) were discharged to home, while 35 patients (12%) required transfer to another facility for a higher level of care. Traumatic and infectious injuries were the most common diagnostic categories at 38% (117/309) and 23% (72/309), respectively. The majority of the traumatic and skin/soft tissue infections were related to the storm.

Conclusion

In this analysis, the majority of the patients seen in a temporary, emergency site were adult, low acuity patients who were dispositioned home, though many did require transfer. A large number of patients were seen directly due to the tornado or recovery efforts. These results may inform future disaster response and suggest the mobile response unit provided necessary care following the storm and hospital's damage.

Table 1. Enhanced Fujita Scale with Corresponding Wind Speeds

Scale	Wind Speed (mph)
EF-0	65-85
EF-1	86-110
EF-2	111-135
EF-3	136-165
EF-4	166-200
EF-5	>200

Abbreviations: EF: Enhanced Fujita; mph: miles per hour

Pediatric <18 years; Adult ≥18 years

Introduction

More tornadoes occur in the United States (U.S.) than in any other country in the world.¹ On average, the U.S. has 800 reported tornadoes annually with an average of 80 deaths and 1500 injuries.² Although yearly death tolls can fluctuate, 2011 was a particularly deadly year, with 553 deaths from tornadoes in that year alone.³ Of those, the Southeastern U.S. was disproportionately impacted, with 342 deaths from Alabama, Arkansas, Mississippi, Georgia, and Tennessee.³ In 2023, Mississippi had the highest number of tornado-related deaths in the U.S with 24 fatalities.⁴ Destruction and injuries can vary greatly from tornadoes, largely due to the location strike of the tornado and strength of the tornado itself.¹ Tornadoes are measured by the Enhanced Fujita (EF) Scale.⁵ The EF Scale considers wind speed along with 28 damage indicators when assigning a strength category to a tornado.⁵ Tornadoes are ranked in order of strength from EF-0 to EF-5 ([Table 1](#)).⁵

Most tornado-related injuries are sustained from flying debris or due to the patient being thrown by the force of the tornado.^{6,7} Impact after being thrown by tornadic winds are more likely to cause death at the scene than at the hospital.⁶ The most common cause of death overall is head injury.⁸ Previous studies suggest extremity injuries, followed by head and chest injuries, are the most common injury sustained.^{8,9} Wound contamination is common, and gram-negative organisms are most frequently reported as causative organisms in patients with wound infections related to these types of events.^{6,8,10}

On April 28, 2014, an EF-4 tornado struck the Louisville, Mississippi, area.¹¹ Maximum wind speeds were estimated at 185 mph.¹¹ EF-4 tornadoes are capable of leveling well-constructed buildings and causing large objects, such as cars, to be thrown.¹² In Louisville, massive amounts of structural damage occurred, and 10 people were killed by the weather system.¹¹ Additionally, the hospital in the area Winston Medical Center was damaged to the point of temporary closure.¹³

A Mobile Emergency Treatment and Training System (METTS) was deployed and utilized in Louisville to temporarily replace the Winston Medical Center. The Mississippi State Medical Assistance Team (MS SMAT) provided emergency medical care to the citizens of Louisville and the surrounding areas.¹³ METTS was created in partnership by the University of Mississippi Medical Center and Mississippi Department of Health. It had very limited capabilities with only 8 treatment beds inside an 18-wheel trailer. Within the first few weeks of use, the local hospital's employees also began to staff the mobile treatment center alongside MS SMAT. There were several limitations to this treatment facility including but not limited to lack of imaging, surgical services, or laboratory services. Telehealth capabilities were available. METTS was replaced by a national mobile hospital funded by FEMA after these 3 weeks.¹⁴

Little was known regarding the anticipated patient population, acuity, and resource needs for the emergency, temporary care site. The purpose of this study is to describe the patient population, diagnoses, and final disposition of patients treated by the METTS.

Methods

A retrospective chart review was performed of all patients treated by the Mississippi State Medical Assistance Team from April 29, 2014, to May 17, 2014, in the temporary, emergency care site. Given the nature of the response and limited resources following the natural disaster, the encounters, including patient data and interventions, were recorded in real time on paper charts. Patient charts were reviewed by two reviewers (JS, JB). A total of 323 patient charts were evaluated in this study.

Age, diagnosis, and disposition were abstracted from the medical records for analysis, with descriptive statistics used as indicated. Due to the variable nature of paper charting and hand-written diagnoses, the types of injuries and diagnoses were grouped into broad categories (Medical, Traumatic, Infectious, Environmental, Neuro-Psychiatric, and Other) to allow for general prevalence of type of complaint to be determined, and additional diagnostic subcategories were developed within each broad category. Infectious diagnoses were a large category. Since many of these infections were due to complications from injuries not initially seen in the emergency care site, it was determined these diagnoses should comprise a separate broad diagnostic category. Final disposition was determined for each encounter.

Study data were collected and managed using REDCap electronic data capture tools hosted at a large university hospital in Mississippi, and the study was approved by the Institutional Review Board.^{15,16} The Strengthening the Reporting of Observation Studies in Epidemiology (STROBE) standard reporting guidelines were used in the reporting of this study.¹⁷

Table 2. Patients Demographics (n= 320)

Pediatric Patients (%)	55 (17%)
Adult Patients (%)	265 (83%)
Mean Age	39.6 years

Table 3. Disposition (n=320)

Discharged	282 (88%)
Transferred*	37 (12%)
Eloped	1

*One patient refused recommended transfer

Results

A total of 323 patient charts were evaluated in this study. Three charts did not have date or birth or age of the patients documented and were excluded from the study. The mean age of patients seen was 39.6 years old, with 55 of 320 (17%) pediatric patients (< 18 years of age) and 265 of 320 (83%) adult patients (≥ 18 years of age). ([Table 2](#)). Of the patients who had a documented disposition, 88% (282/320) were discharged and 12% were transferred (37/320). Five out of the 37 patients that were recommended to be transferred were pediatric patients. One patient refused transfer despite recommendation, and one patient eloped before final disposition was recommended. No patients seen in this site during this period were documented as deceased or were dispositioned to the morgue ([Table 3](#)).

Of the 320 patients in the study, a diagnosis was determined in 309 of the charts (96%). Of these patients, 38% had a traumatic diagnosis, 23% had an infectious diagnosis, 19% had a medical diagnosis, and 4% had an environmental diagnosis. In some cases (28 of 309), it was difficult to determine if a diagnosis clearly fit within one of those four categories and were included in the “Other” category. Some examples of diagnoses included in this category include foreign body ingestions and eye complaints ([Table 4](#)).

As seen in [Table 4](#), the most common diagnostic subcategory overall was musculoskeletal pain (55 of 309 (18%)). The majority of these complaints were documented as contusions that occurred during the storm. Although musculoskeletal pain was the most common subcategory overall and within traumatic diagnoses, lacerations, foot puncture wounds, and wound check/suture removal compromised 39% (46 of 117) of diagnoses within the Traumatic category ([Table 4](#)). All puncture wounds to the foot were documented as occurring due to stepping on nails during the storm’s aftermath, and a majority of the lacerations and wound infections were

Table 4. Diagnoses by Categories (n = 309)

Traumatic	121 (39%)
Musculoskeletal Pain	55
Laceration	22
Foot Puncture Wound	13
Fracture	7
Head Trauma	8
Polytrauma	5
Wound check/suture removal	11
Medical	59 (19%)
Abdominal Pain	23
Asthma/COPD Exacerbation	13
Chest Pain	9
Syncope	2
Other	4
Medication Refill	8
Neuro-Psychiatric	17 (6%)
Seizures	4
Psychiatric	6
Headache	5
Stroke/TIA	2
Environmental	12 (4%)
Insect/Snakebite	7
Dehydration/Heat Illness	5
Infectious	72 (23%)
URI/Bronchitis/Pharyngitis	27
Skin/Soft Tissue Infection	26
UTI/STI/PID	13
Acute Otitis Media	6
Other	28 (9%)
Eye Complaints	9
Other	19

Abbreviations: COPD: Chronic Obstructive Pulmonary Disease; TIA: Transient Ischemic Attack; URI: Upper Respiratory Infection; UTI: Urinary Tract Infection; STI: Sexually Transmitted Infection; PID: Pelvic Inflammatory Disease

related to injuries sustained during the tornado or recovery efforts. In some cases, chainsaws used during recovery efforts were documented as the cause of injury.

URI/Bronchitis/Pharyngitis was the second most common diagnostic subcategory overall, followed closely by Skin/Soft tissue infections at 9% (27/309) and 8% (26/309), respectively. Medical complaints were common diagnoses, as well. Abdominal pain, chest pain, and asthma/COPD exacerbations were the most common medical subcategories seen during the time frame ([Table 4](#)).

Discussion

In this study, we sought to describe the patient population seen in a temporary, emergency mobile hospital after destruction of the local, rural hospital during an EF-4 tornado. Little was known regarding the expected patient demographics, acuity, diagnoses, and dispositions that emergency responders would encounter. Our results show that the majority of the patients seen in this temporary, rural emergency site were adult patients who were low acuity in nature and were able to be discharged home, although 12% of patients required transfer to a hospital for a higher level of care. Many patients that required treatment and preventative care suffered injuries as a direct result of storm related injuries and/or recovery efforts. These results could help inform future disaster response and suggest the mobile response unit provided necessary care following the storm and hospital damage.

During the immediate aftermath of an EF-4 tornado and the resultant destruction of the local hospital, few medical resources were available in Louisville.¹³ The town sustained significant infrastructure damage, and ten of its citizens were killed in the storm system.¹³ Located in rural Mississippi, the closest hospitals outside of Louisville, Choctaw Regional Medical Center and Neshoba County General Hospital, are both designated as critical access hospitals and are located 17 miles and 27 miles away, respectively.¹⁸ During repairs to the local hospital, the Mississippi State Medical Assistance Team and local hospital employees provided local emergency care via a temporary emergency, mobile hospital.¹³ For nearly three weeks, care was provided to over 300 patients. Resources were limited with no laboratory or radiographic studies available.

In this analysis, the majority of patients seen were able to be discharged without diagnostics testing, suggesting they were low acuity patients. However, many patients did have infectious etiologies for their complaints that required treatment, many of which were directly attributed to injuries sustained in the storm or in post-storm recovery efforts. Contusions, lacerations, and puncture wounds to the foot were common diagnoses. Skin and soft tissues infections due to injuries sustained in the storm were common, too. This figuring is consistent with previous literature on tornado-related injuries.⁶⁻⁹ In addition to tornado-related injuries, common medical complaints and non-tornado-related complaints were seen, as well, like medication refills, otitis media, and asthma/COPD exacerbations. No fatalities were seen at the temporary field hospital, though 12% of patients required transfer to a hospital with a higher level of care, with final diagnoses and disposition unknown.

These results suggest that the Mississippi State Medical Assistance Team and local hospital employees were able to provide necessary care to local, rural patients through the temporary mobile site. By evaluating and treating patients in Louisville, they were able to care for patients and likely prevent

further harm and complications from injuries sustained during and after the storm. Further, they were able to provide this care in the patients' local area, preventing patients from seeking care in other facilities that would require transportation and resources that were particularly scarce during that time. Even during times when the city is not affected by a natural disaster, transportation for medical care is often out of reach for many patients in the area. With a median income of just over \$36,000, 35% of the population lives below the poverty line.¹⁹ Further, like many hospitals in Mississippi, the closest hospitals to Louisville have critical access designations and are resource-limited themselves. Referral centers are limited in the state and typically require prolonged transport. Coupled with hospital and ED boarding crises many hospitals are facing, off-loading hospitals during times of natural disaster, when clinics and ambulatory settings are often closed, as well, could be crucial for quality emergency care.^{20,21}

To our knowledge, there is little in the literature regarding patients seen during emergency response in the immediate aftermath of a tornado when the local hospital is non-operable. These results could help inform preparation, training, and staffing for the emergency response team. Also, state agencies are often limited in resources and funding and often have to make challenging decisions regarding resource allocation. These results suggest that the mobile unit provided valuable care for a vulnerable, rural patient population and potentially off-loaded surrounding hospital systems.

Our study has several limitations. This was a retrospective study and descriptive analysis with the inherent limitations of that study design. Additionally, as a mobile disaster response team, documentation was limited, and this limitation constrained granularity in documentation, specifically diagnoses and patient demographics in some cases. Finally, this study evaluated one mobile, disaster response team in rural Mississippi without a functional hospital at the time, so the results may not be generalizable.

Conclusion

In this study of over 300 patients seen in a temporary, mobile, emergency response site established after an EF-4 tornado damaged the local, rural hospital, many of these patients were treated and discharged from this emergency department, avoiding the need for additional resources required to emergently transport these patients to another facility. The majority of patients were adults with diagnoses primarily due to injuries related to the tornado or recovery efforts. These findings may have important implications for future disaster management planning, response, and resource allocation.

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