

# Hurricane Shutter-Related Injuries Treated in Emergency Departments

Mathias B. Forrester, BS

## ABSTRACT

**Objectives:** Injuries may occur when putting up and taking down hurricane (storm) shutters. This study described hurricane shutter-related injuries managed at emergency departments (EDs).

**Methods:** Hurricane shutter-related injuries were identified through the National Electronic Injury Surveillance System (NEISS), a database of consumer product-related injuries collected from the EDs of approximately 100 United States hospitals.

**Results:** There were 329 hurricane shutter-related injuries during 2001-2017. Thirty-six injuries were reported during October 2005 (Hurricane Wilma), 30 during August 2008 (Tropical Storm Fay), and 103 during September 2017 (Hurricane Irma). Patients were 20 years or older in 90.6% of the cases; 76.3% of the patients were male. The most frequently reported injuries were laceration (48.9%), sprain or strain (15.2%), and fracture (9.4%). Lower extremities (34.0%) were the most commonly affected body part followed by upper extremities (29.5%) and head or neck (17.0%). The patient was treated or examined at the ED and released in 86.6% of the cases.

**Conclusions:** Over half of the hurricane shutter-related injuries appeared to occur in association with hurricanes and tropical storms. The most frequently reported injuries were laceration followed by sprain or strain and fracture. The majority of patients were treated or examined at the ED and released.

**Key Words:** emergency department, hurricane shutter, injury, storm shutter

Hurricanes and tropical storms can result in injury and death, either directly or indirectly. Directly caused injuries include trauma, drowning, asphyxiation, and electrocution.<sup>1-5</sup> Indirectly caused injuries include exacerbation of medical conditions, infection, poisoning (eg, carbon monoxide, gasoline), bites and stings, vehicular crashes, and preparation or repair injuries (eg, falls, electrocution).<sup>1-14</sup> Injuries may occur before the storm makes landfall.<sup>1</sup> One study reported that 12% of deaths associated with Hurricane Irma were related to preparation and repair injuries.<sup>1</sup>

In hurricane-prone regions, hurricane or storm shutters provide protection for glass windows and doors against windborne debris that occur during hurricanes. If windows or doors break, in addition to the broken glass that may cause injuries, sudden pressurization of the interior of a building may result in structural or non-structural damage. Although shutters will not eliminate the possibility of wind-driven rain entering a building, it will improve the building's resistance and possibly reduce the risk of broken glass. A wide variety of hurricane shutter types are available and may be made of wood, metal, and polycarbonate. Shutters may be recommended or required in hurricane-prone areas.<sup>15</sup>

Injuries may occur when putting up and taking down hurricane shutters. When Hurricane Frances struck in 2004, doctors in Palm Beach County and Broward County, Florida, reported that the most common injuries were sustained by people trying to put up and take down hurricane shutters and plywood.<sup>16</sup> Such injuries tend to not be life-threatening and consist of lacerations to hands, arms, and legs, including lacerations to tendons (because shutters may have sharp edges and people do not wear work gloves); falls from ladders; and back injuries.<sup>16</sup>

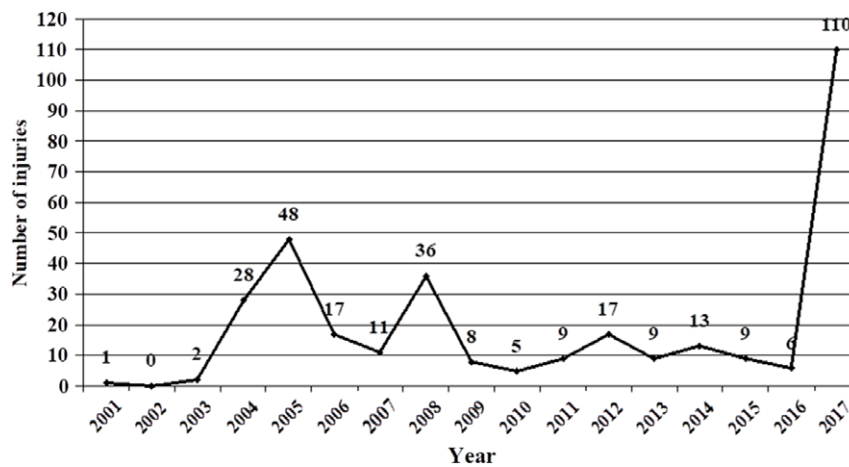
A review of PubMed and the Internet failed to identify any studies published in peer-review journals examining injuries associated with hurricane shutters. The objective of this study was to describe hurricane shutter-related injuries managed at emergency departments (EDs). In particular, a comparison was made between the temporal pattern of injuries and the landfall of selected hurricanes and tropical storms in the United States (US).

## METHODS

The data source for this study was the National Electronic Injury Surveillance System (NEISS)

FIGURE 1

Annual Number of Hurricane Shutter-Related Injuries Treated in US EDs, NEISS.



operated by the US Consumer Product Safety Commission (CPSC). The NEISS collects data on consumer product-related injuries from the EDs of approximately 100 hospitals as a probabilistic sample of the more than 5000 US hospitals with EDs. The NEISS is a stratified sample based on ED size and geographic location. Information collected include the patient's age, sex, race, ethnicity, injury diagnosis, body parts affected, and location where the injury occurred, among others.<sup>17</sup> NEISS data are publicly available and de-identified; therefore, the study is exempt from institutional review board approval.

Cases were hurricane shutter-related injuries in the NEISS database that occurred during 2001-2017. The Narrative\_1 and Narrative\_2 text fields were searched for any mention of the terms "shutter" and "hurricane," "storm," "metal," "aluminum," or "plywood." The resulting records were then reviewed to determine whether the injury appeared to be related to the shutter. All records that mention "shutter" in the Narrative\_1 and Narrative\_2 text fields were not included because some of the shutters involved in injuries might not be hurricane shutters but regular shutters.

The distribution by selected variables was determined for the resulting cases as well as a weighted estimate calculated by the sum of the numbers in the Weight number field. It should be noted that the CPSC considers an estimate unstable and potentially unreliable when the estimate is less than 1200, the number of records used is less than 20, or the coefficient of variation (CV) exceeds 33%.<sup>17</sup>

The geographic distribution (ie, state or county) of the cases could not be examined because such information was not available in the public NEISS database. The distribution of the cases by year was determined. For any years where there

seemed to be a higher number of cases, the distribution of cases by month and day was examined to identify any apparent clusters of cases. These clusters were then compared with the reported dates of landfall of hurricanes and tropical storms in the United States. Because of the small number of cases in small time-frames, weighted estimates were not calculated for the temporal analyses.

## RESULTS

During 2001-2017, a total of 329 hurricane shutter-related injuries occurred and were reported to the NEISS, resulting in a national estimate of 19,335 injuries during that time period. Figure 1 shows the annual number of hurricane shutter-related injuries. While few injuries were reported during most years, higher numbers were reported during 2005 (14.6% of total), 2008 (10.9% of total), and 2017 (33.4% of total). When the monthly number of injuries were examined for these 3 years, the majority of the injuries were reported during October 2005 ( $n=36$ ), August 2008 ( $n=30$ ), and September 2017 ( $n=103$ ); these 3 months accounted for 169 (51.4%) of the total injuries during 2001-2017. Table 1 presents the number of hurricane shutter-related injuries during these 3 months and selected others when major hurricanes made landfall in the United States. Hurricane Wilma made landfall in October 2005, Tropical Storm Fay in August 2008, and Hurricane Irma in September 2017; all 3 made initial landfall in Florida. Fifteen (4.6%) hurricane shutter-related injuries in total were reported in the months of the 5 other storms examined (Hurricane Ivan in September 2004, Hurricane Katrina in August 2005, Hurricane Ike in September 2009, Hurricane Sandy in October 2012, Hurricane Harvey in August 2017). Figure 2 provides the daily number of hurricane shutter-related injuries for the 10 days

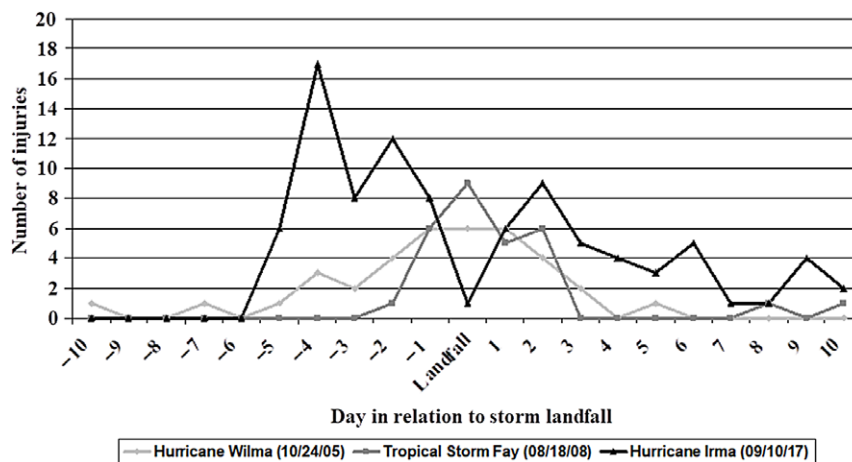
TABLE 1

Number of Hurricane Shutter-Related Injuries Treated in US EDs, NEISS, During Selected Months With Storms				
Month, Year	Number of Cases	Annual Number of Cases	Percent of Annual Cases	Storm Name, Date, and State of Landfall
September 2004	11	28	39.3	Hurricane Ivan September 16, Alabama
August 2005	2	48	4.2	Hurricane Katrina August 25, Florida August 29, Louisiana
October 2005	36	48	75.0	Hurricane Wilma October 24, Florida
August 2008	30	36	83.3	Tropical Storm Fay August 18, Florida
September 2009	1	8	12.5	Hurricane Ike September 13, Texas
October 2012	1	17	5.9	Hurricane Sandy October 27, New Jersey
August 2017	0	110	0.0	Hurricane Harvey August 25, Texas
September 2017	103	110	93.6	Hurricane Irma September 10, Florida

Abbreviations: ED, emergency department; NEISS, National Electronic Injury Surveillance System; US, United States.

FIGURE 2

Daily Number of Hurricane Shutter-Related Injuries, NEISS.



before landfall, the day of landfall, and the 10 days after landfall for Hurricane Wilma, Tropical Storm Fay, and Hurricane Irma. The number of reported hurricane shutter-related injuries began to increase days before landfall and continued for days after landfall for all 3 storms.

Table 2 shows the distribution of hurricane shutter-related injuries by patient demographics and the circumstances of the injury. The majority of the patients were adults with the highest proportions being age 60-69 years followed by 30-39 years. Most of the patients were male. Almost all of the injuries occurred at the patient's home.

The most frequently reported injuries were laceration followed by sprain or strain, fracture, and contusions or abrasions. Lower extremities were the most commonly affected body part followed by the upper extremity and head or neck. The majority of patients were treated or examined at the ED and released; 1 death was reported (Table 3).

## DISCUSSION

Hurricane shutter-related injuries may occur with hurricanes and tropical storms.<sup>16</sup> Of the 329 hurricane shutter-related injuries identified during 2001-2017, over half were reported

TABLE 2

**Demographics and Circumstances of Hurricane Shutter-Related Injuries Treated in US EDs, NEISS, 2001-2017**

Variable	Number		Estimate <sup>a</sup>	
	Number	Percent	Number	Percent
Patient age (years)				
00-05 <sup>b</sup>	7	2.1	446	2.3
06-12 <sup>b</sup>	7	2.1	469	2.4
13-19 <sup>b</sup>	17	5.2	1,092	5.6
20-29	30	9.1	1,706	8.8
30-39	55	16.7	3,076	15.9
40-49	48	14.6	2,645	13.7
50-59	49	14.9	2,683	13.9
60-69	57	17.3	3,503	18.1
70-79	42	12.8	2,673	13.8
80+ <sup>b</sup>	17	5.2	1,040	5.4
Patient sex				
Male	251	76.3	14,343	74.2
Female	78	23.7	4,992	25.8
Race				
White	148	45.0	8,282	42.8
Black/African American <sup>b</sup>	4	1.2	208	1.1
Other <sup>b</sup>	11	3.3	559	2.9
Not stated	166	50.5	10,286	53.2
Ethnicity reported as				
Hispanic				
Yes <sup>b</sup>	10	3.0	542	2.8
No	319	97.0	18,793	97.2
Location				
Home	321	97.6	18,837	97.4
Public property <sup>b</sup>	1	0.3	16	0.1
Unknown <sup>b</sup>	7	2.1	482	2.5
Total	329		19,335	

<sup>a</sup> Estimate = sum of the Weight field.

<sup>b</sup> The US Consumer Product Safety Commission considers an estimate unstable and potentially unreliable when the number of records used is less than 20 or the estimate is less than 1200. Therefore, the estimate for this subgroup should be considered unstable and potentially unreliable.

Abbreviations: ED, emergency department; NEISS, National Electronic Injury Surveillance System; US, United States.

during 3 specific months (October 2005, August 2008, September 2017) with over 30% reported during 1 of these months (September 2017). During these 3 months, storms made landfall in the United States: Hurricane Wilma in October 2005, Tropical Storm Fay in August 2008, and Hurricane Irma in September 2017. When the daily number of injuries was examined in relation to the landfall of these 3 storms (Figure 2), the number of reported injuries began to increase days before landfall and continued for days after landfall for all 3 storms.

These observations suggest that individuals are at increased risk of hurricane shutter-related injuries around the time hurricanes and tropical storms make landfall. Moreover, injuries might occur in the days before the storm makes landfall, as hurricane shutters are installed, and continue for days afterward, as the shutters are removed. It should be emphasized that this

relationship between injuries and storms is based solely on examination of the dates of the injuries and storms. The NEISS public database does not contain information on the geographic location of the hospital EDs where the patients were treated. Thus, some of the injuries may be close to the landfall of a storm in time but widely separated geographically.

Also, hurricanes and tropical storms differed in the number of hurricane shutter-related injuries that occurred in the month they made landfall, with few injuries reported with some of the storms, such as Hurricane Ivan, Hurricane Katrina, Hurricane Ike, Hurricane Sandy, and Hurricane Harvey (Table 1). Thus, it might be difficult to predict the number of hurricane shutter-related injuries that might occur with a particular storm. Hurricanes and tropical storms may differ in the degree of hurricane shutter-related injuries that occur due to differences in the characteristics of the storm (eg, wind strength) and where the storm made landfall. There may be geographic differences in the requirement or use of hurricane shutters. Also, for those storms with few reported injuries, the hospital EDs where these hurricane shutter injuries may have been treated may not have been included in the NEISS.

It may be noted that these patterns were based on a relatively small number of reported hurricane shutter injuries. Although the 3 months with the highest number of hurricane shutter injuries (October 2005, August 2008, September 2017) accounted for over half of all such injuries, there were only a total of 169 injuries. This may be considered small when the storms that made landfall during these months (Hurricane Wilma, Tropical Storm Fay, Hurricane Irma, respectively) affected millions of people, often in multiple states. However, as indicated in the Methods section, these injuries are from hospital EDs that are a probabilistic sample of all US hospital EDs and are not injuries that were treated at all US hospital EDs. The injuries in the NEISS database can be used to calculate an estimate of the total number of injuries. In this instance, the 169 injuries result in an estimated 9775 hurricane shutter injuries during these 3 months. Furthermore, all of the individuals affected by a storm may not be at equal risk of a hurricane shutter injury. Individuals further inland may not be expected or required to put up hurricane shutters.

The majority of the patients were male, and most were adults, with the highest proportions being age 60-69 years followed by 30-39 years. Almost all of the injuries occurred at the patient's home. This might be expected if the injuries occurred during installation or removal of hurricane shutters from the home.

The injuries were most often laceration, sprain or strain, fracture, and contusions or abrasions. The affected body part was most often the lower extremity followed by the upper extremity and head or neck. Most of patients were treated or examined at the ED and released. A news article suggested that hurricane shutter-related injuries tended not to be life-threatening and consist of lacerations, falls, and back injuries.<sup>16</sup>

TABLE 3

**Type and Management of Hurricane shutter-related injuries treated in US EDs, NEISS, 2001-2017**

Variable	Number		Estimate <sup>a</sup>	
	Number	Percent	Number	Percent
Type of injury				
Laceration	161	48.9	9,723	50.3
Sprain, strain	50	15.2	2,904	15.0
Fracture	31	9.4	1,561	8.1
Contusions, abrasions <sup>b</sup>	20	6.1	1,125	5.8
Internal injury <sup>b</sup>	15	4.6	746	3.9
Foreign body <sup>b</sup>	3	0.9	176	0.9
Avulsion <sup>b</sup>	3	0.9	170	0.9
Dislocation <sup>b</sup>	2	0.6	91	0.5
Puncture <sup>b</sup>	2	0.6	145	0.8
Dermal <sup>b</sup>	2	0.6	96	0.5
Amputation <sup>b</sup>	1	0.3	15	0.1
Concussion <sup>b</sup>	1	0.3	15	0.1
Crushing <sup>b</sup>	1	0.3	100	0.5
Other	37	11.2	2,467	12.8
Affected body part				
Lower extremity	112	34.0	6,371	32.9
Upper extremity	97	29.5	5,873	30.4
Head/neck	56	17.0	3,018	15.6
Trunk	53	16.1	3,280	17.0
All parts of body <sup>b</sup>	11	3.3	793	4.1
Disposition				
Treated/examined and released	285	86.6	16,735	86.6
Treated and admitted/hospitalized	43	13.1	2,520	13.0
Fatality	1	0.3	79	0.4
Total	329		19,335	

<sup>a</sup> Estimate = sum of the Weight field

<sup>b</sup> The US Consumer Product Safety Commission considers an estimate unstable and potentially unreliable when the number of records used is less than 20 or the estimate is less than 1200. Therefore, the estimate for this subgroup should be considered unstable and potentially unreliable.

Abbreviations: ED, emergency department; NEISS, National Electronic Injury Surveillance System; US, United States.

The results of this study do not suggest ways to prevent hurricane shutter injuries. However, precautions have been recommended by others to minimize the risk of hurricane shutter-related injuries. Work gloves should be worn to avoid lacerations and splinters. Shutters should be installed before the storm winds increase. More than 1 person should be involved in the installation or removal of the shutters to assist in the handling of the heavy shutters and securing the ladder. Persons should be careful of their posture and bend with their knees to avoid back injuries. Any ladders should be checked before use. Plenty of time should be allotted for the installation and removal of shutters.<sup>18</sup>

There are limitations to this study. Cases were identified by searching for “shutter” and “hurricane,” “storm,” “metal,” “aluminum,” or “plywood” in the electronic record narrative. Hurricane shutter-related injuries where these terms were not

documented in the narrative would not have been included in this study. Also, some of the injuries included in the study might not have been related to hurricane shutters but to other types of shutters, such as regular shutters. Only those injuries treated at an ED were included. The number of hurricane shutter-related injuries not seen at an ED is unknown. In addition, there were relatively few cases. This is particularly important when calculating estimates, which may be unstable and potentially unreliable when small numbers of cases are being examined. As mentioned previously, the geographic location (eg, state or county) of the ED where the patient was treated was not available in the NEISS public database. This limited the ability to more definitively link particular injuries to particular storms. This study was limited to hospital EDs in the United States. It is unclear whether other countries affected by such storms may also experience hurricane shutter-related injuries, and if they do, whether such injuries would follow a similar pattern. Studies of hurricane shutter-related injuries in other countries would be useful to add to information on this topic.

## CONCLUSIONS

Over half of the hurricane shutter-related injuries reported to EDs appeared to occur in association with hurricanes and tropical storms. Most patients were male and adults. The majority of injuries occurred at home. The most frequently reported injuries were laceration followed by sprain or strain, fracture, and contusions or abrasions. Lower extremities were the most commonly affected body part followed by the upper extremity and head or neck. The majority of patients were treated or examined at the ED and released.

## About the Author

*Independent Researcher, Austin, Texas (Mr Forrester).*

*Correspondence and reprint requests to Mathias B. Forrester, Independent Researcher, 4600 Monterey Oaks Boulevard #F2335, Austin, Texas 78749, USA. telephone: 512-659-3627; e-mail: mathias.forrester@gmail.com.*

## REFERENCES

1. Issa A, Ramadugu K, Mulay P, et al. Deaths related to Hurricane Irma - Florida, Georgia, and North Carolina, September 4-October 10, 2017. *MMWR Morb Mortal Wkly Rep.* 2018;67:829-832.
2. Centers for Disease Control and Prevention (CDC). Deaths associated with Hurricane Sandy - October-November 2012. *MMWR Morb Mortal Wkly Rep.* 2013;62:393-397.
3. Choudhary E, Zane DF, Beasley C, et al. Evaluation of active mortality surveillance system data for monitoring hurricane-related deaths - Texas, 2008. *Prehosp Disaster Med.* 2012;27:392-397.
4. Zane DF, Bayleyegm TM, Hellsten J, et al. Tracking deaths related to Hurricane Ike, Texas, 2008. *Disaster Med Public Health Prep.* 2011;5:23-28.
5. Ragan P, Schulte J, Nelson SJ, et al. Mortality surveillance: 2004 to 2005 Florida hurricane-related deaths. *Am J Forensic Med Pathol.* 2008;29:148-153.
6. Curran T, Bogdanovski DA, Hicks AS, et al. The effects of Hurricane Sandy on trauma center admissions. *Eur J Trauma Emerg Surg.* 2018;44:137-141.

## Hurricane Shutter-Related Injuries

7. Marshall EG, Lu SE, Williams AO, et al. Tree-related injuries associated with response and recovery from Hurricane Sandy, New Jersey, 2011-2014. *Public Health Rep.* 2018;133:266-273.
8. Schnall A, Law R, Heinzerling A, et al. Characterization of carbon monoxide exposure during Hurricane Sandy and subsequent nor'easter. *Disaster Med Public Health Prep.* 2017;11:562-567.
9. Brackbill RM, Caramanica K, Maliniak M, et al. Nonfatal injuries 1 week after Hurricane Sandy - New York City metropolitan area, October 2012. *MMWR Morb Mortal Wkly Rep.* 2014;63:950-954.
10. Kim HK, Takematsu M, Biary R, et al. Epidemic gasoline exposures following Hurricane Sandy. *Prehosp Disaster Med.* 2013;28:586-591.
11. Warner GS. Increased incidence of domestic animal bites following a disaster due to natural hazards. *Prehosp Disaster Med.* 2010;25:188-190.
12. Centers for Disease Control and Prevention. Carbon monoxide exposures after Hurricane Ike - Texas, September 2008. *MMWR Morb Mortal Wkly Rep.* 2009;58:845-849.
13. Forrester MB. Impact of Hurricane Ike on Texas poison center calls. *Disaster Med Public Health Prep.* 2009;3:151-157.
14. Sullivent EE, West CA, Noe RS, et al. Nonfatal injuries following Hurricane Katrina - New Orleans, Louisiana, 2005. *J Safety Res.* 2006;37:213-217.
15. Federal Emergency Management Agency (FEMA). Protection of openings - shutters and glazing. Home builders guide to coastal construction. Technical fact sheet 6.2. 2010. [https://www.fema.gov/media-library-data/20130726-1537-20490-6588/fema499\\_6\\_2.pdf](https://www.fema.gov/media-library-data/20130726-1537-20490-6588/fema499_6_2.pdf). (Accessed June 8, 2019).
16. Pacenti J. Hurricane Irma: how to avoid injuries putting up storm shutters. *The Palm Beach Post.* September 5, 2017. <https://www.palmbeachpost.com/news/breaking-news/hurricane-irma-how-avoid-injuries-putting-storm-shutters/lrrxkuCmLoRu2ZCNTRxvyH/>. (Accessed June 11, 2019).
17. United States Consumer Product Safety Commission. National Electronic Injury Surveillance System (NEISS). <https://www.cpsc.gov/Safety-Education/Safety-Guides/General-Information/National-Electronic-Injury-Surveillance-System-NEISS>. (Accessed February 9, 2010).
18. Tidelands Health. Hurricane Irma: how to safely install hurricane shutters. *Tidelands Health.* September 6, 2019. <https://www.tidelandshealth.org/newsroom/2017/hurricane-irma-how-to-safely-install-hurricane-shutters/>. (Accessed June 11, 2019).