Effect of Fireworks Laws on Pediatric Fireworks-Related Burn Injuries

John Myers, PhD, MSPH, Carlee Lehna, PhD, ARNP

Changes in U.S. fireworks laws have allowed younger children to purchase fireworks. In addition, the changes have allowed individuals to purchase more powerful fireworks. The purpose of this study is to examine the epidemiology of pediatric firework-related burn injuries among a nationally representative sample of the United States for the years 2006 to 2012. We examined inpatient admissions for pediatric firework-related burn patients from 2006 to 2012 using the nationwide inpatient sample and examined emergency department admissions using the nationwide emergency department sample. Both data sources are part of the Healthcare Cost and Utilization Project. Trajectories over time were evaluated. A total of 3193 injuries represented an estimated 90,257 firework-related injuries treated in the United States from 2006 to 2012. A majority of injuries were managed in the emergency department (n = 2008, 62.9%). The incidence generally increased over time; increasing from 4.28 per 100,000 population in 2006 to 5.12 per 100,000 population in 2012, $P = .019$. However, the proportion of injuries requiring inpatient admission (28.9% in 2006 to 50.0% in 2012, $P < .001$) and mean length of stay in the hospital (3.12 days in 2006 to 7.35 days in 2012, $P < .001$) significantly increased over time, while the mean age decreased over time (12.1-year-old in 2006 to 11.4-year-old in 2012, $P = .006$). The relaxing of U.S. fireworks laws may have had a modest effect on incidence of related injuries and the age of purchaser. However, it has had a dramatic effect on the severity of the related injuries, resulting in more inpatient admissions and longer length of stay in the hospital. Preventative methods should be taken to reduce the rate and severity of firework-related injuries among U.S. youths. (J Burn Care Res 2017;38:e79–e82)

An estimated 14,280 firework-related burn injuries were treated in U.S. emergency rooms and hospitals in 2010, with half (n = 7160, 50.1%) of these injuries occurring in children. Unfortunately, in the face of these statistics, no comprehensive report exists concerning the fireworks problem in the pediatric literature. Similarly, no empirical evidence exists examining the impact an outwardly relaxing of fireworks laws has had for children.

Fireworks are defined as devices "designed for the purpose of producing a visible or audible effect by combustion, deflagration, or detonation."[1,2] While others have suggested that the annual number of children receiving treatment for firework-related injuries has decreased recently;[3,4] no report has investigated the severity of the injury or its proxy (requiring inpatient services, length of stay [LOS] in the hospital, total costs, etc.). Burns account for more than half of firework-related injuries, while lacerations, contusions, and abrasions are also common.[3,5]

Since 1966, the federal government has imposed a ban on large, exploding fireworks containing more than 130 mg (two grains) of explosive material.[3] Mail-order kits to build such fireworks have also been banned.[3] At the same time, the U.S. Consumer Product Safety Commission (CPSC) was given responsibility for regulating fireworks under the Federal Hazardous Substances Act.

Fireworks are classified by the CPSC as follows: Class B devices, which include cherry bombs, M-80s, and large firecrackers, are banned. Allowable "class C" devices include fountains and California candles (which emit showers of sparks); Roman candles (which shoot out a series of flaming balls); rockets with sticks; and

From the Department of Pediatrics, University of Louisville, Kentucky.
Address correspondence to John Myers, PhD, MSPH, School of Medicine, University of Louisville, 555 South Floyd Street, Suite 4058, Louisville, Kentucky 40202. Email: john.myers@louisville.edu.
Supplemental digital content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's Web site.

1559-047X/2016
DOI: 10.1097/BCR.0000000000000435

helicopter- and missile-type rockets; sparklers; smoke devices; and miscellaneous other types. The class C fireworks were allowed for sale because the CPSC believed that quality control and mandatory labeling requirements would provide adequate protection of the public. However, it is individual State laws that govern the sale and use of class C (or "common") fireworks[6] (see Appendix, Supplemental Digital Content 1, at http://links.lww.com/BCR/A65). In 1984, 14 states had a total ban on Class C fireworks[1]; in 2001, 10 states had a total ban[7]; now only six have a total ban. In addition, the age requirement to purchase has decreased over time and larger/more powerful fireworks can now be purchased.

One would expect that as laws (total bans and/or strength of laws) have relaxed over time more injuries have been reported and that the severity of injury has increased as well. Certainly, fireworks distributors have argued that relaxation of laws has resulted in decreased injuries because they discourage use of more dangerous homemade illegal devices with questionable quality control. In the current study, we test the hypothesis that rates/severity of pediatric firework-related burn injuries has changed over time in a time period of relaxed fireworks laws. That is, the purpose of this study is to examine the epidemiology of pediatric firework-related burn injuries among a nationally representative sample of the United States for the years 2006 to 2012.

METHODS

Data from the National Inpatient Sample (NIS) and the Nationwide Emergency Department Sample (NEDS) were used (Figure 1).[8,9] The NIS is the largest publicly available all-payer inpatient care database in the United States and it contains data from approximately 8 million hospital stays each year (a 20% stratified sample of U.S. community hospitals).[8] The sampling methodology aims to capture a representative sample of all U.S. community hospital discharges, which come from the State Inpatient Databases and includes >95% of the target universe. The strata used in creating the NIS are U.S. division, urban or rural location, teaching status, ownership, and bed size. The NIS sample unit is a systematic random sample of discharges stratified by hospital characteristics. The sample includes approximately 20% of discharges from U.S. community hospitals.

The NEDS is the largest all-payer emergency department (ED) database in the United States containing data from approximately 30 million discharges from emergency medicine facilities each year.[9] The NEDS is a stratified sample of U.S. hospitals. The target universe for the NEDS is all U.S. community hospital-based EDs. The NEDS includes data on care that began in the ED regardless of whether the patient was treated and released or admitted to the hospital. Hospitals used in the NEDS database are categorized according to five strata. The strata include geographic region, location, teaching status, ownership, and trauma-level designation. A 20% stratified random sample of U.S. hospital-based EDs is then selected. Once the hospitals have been selected, 100% of all ED visits from the selected hospitals are included in the NEDS. This type of sampling design is referred to as a stratified, single-stage cluster sample.

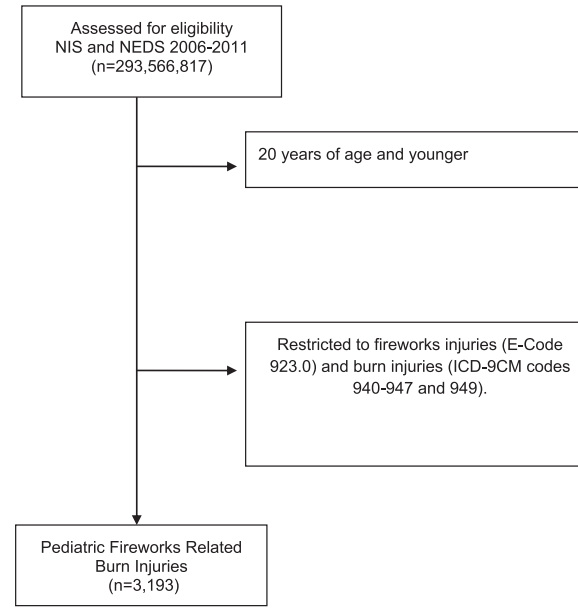

Figure 1. Flow diagram to develop analytic sample. *ICD-9-CM*, International Classification of Diseases, Ninth Revision, Clinical Modification; *NEDS*, Nationwide Emergency Department Sample; *NIS*, National Inpatient Sample.

Since NEDS data are currently only available from 2006 to 2012, data from both the NIS and NEDS from 2006 to 2012 were used in the current study. The analytic sample consisted of individuals who were 1) 20 years of age and younger and 2) had an International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) for a burn and an E-code for firework-related injury. No direct patient identifiers are available in the datasets. A Data Use Agreement is required on purchase of the databases. Because only de-identified data were used, approval was not required from the institutional review board.

Fireworks Injury

First, we identified within the two datasets (n = 293,566,817), individuals who suffered a

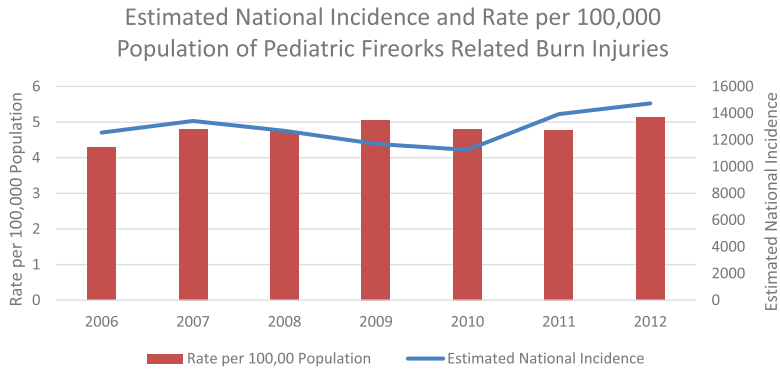

Figure 2. The estimated national incidence and rate per 100,000 population of pediatric firework-related burn injuries

firework-related injury (n = 59,350), using E-code 923.0 (accident caused by explosive material, fireworks).

Burn Injury

Second, from the restricted dataset, we identified those who suffered a burn injury (n = 3193), see Figure 1. Burns were defined in the current study by ICD-9-CM Diagnosis Codes: 940 to 947 and 949 (940: burns of eye and adnexa; 941: burns of face, head, and neck; 942: burns of the trunk; 943: burns of upper limb; 944: burns of hands/wrists; 945: burns of lower limb; 946: burns of multiple specified sites; 947: burns of internal organs; and 949: unspecified burns). ICD-9-CM diagnosis code 948 (total burn surface area) was not included and code 946 is TBSA (Figure 2).

The NIH has recently changed their definition of "children' from less than 21 years of age to less than 18 years of age (https://grants.nih.gov/grants/guide/notice-files/NOT-OD-16-010.html). However, since the databases used for analysis coded/identified those under the age of 21 years as children/pediatric, we chose to be consistent and define children/pediatric as less than 21 years of age. Moreover, a majority of pediatricians and pediatric researchers would argue that development and maturity continues well past 18 years of age. The definition of children was changed by the NIH to more directly coincide with age of consent and independent inclusion in studies. As such, we decided to keep the older definition for "children" to be explicitly in line with the vision of the architects of the databases and to allow our results to be generalizable to a broader definition of children who are vulnerable to firework-related burns."

Statistical Analysis

Using descriptive analyses, we examined the distribution of pediatric firework-related burn injuries over time (for children less than 21 years of age). In addition, we explored the frequency of children being managed in the ED compared with inpatient hospitalization and whether the incidence of pediatric firework-related burn injuries has changed over time. The overall pediatric firework-related burn injuries incidence rate was calculated per 100,000 population (using 2006–2012 Census data) and a χ^2 test was performed to compare annual incidences. A serial cross-sectional study design was initially used, while subsequently generalized linear mixed-effects models were developed to test if the rate and/or severity of illness changed over time.

RESULTS

A total of 3193 injuries represented an estimated 90,257 firework-related burn injuries treated in

Table 1. Reported pediatric firework-related burn injuries in the analytical dataset and the estimated national incidence and rate per 100,000 population

Year	Injuries in Dataset	Estimated National Incidence	Rate Per 100,00 Population
2006	624	12,542	4.28
2007	517	13,420	4.51
2008	335	12,677	4.74
2009	308	11,699	5.06
2010	391	11,250	4.83
2011	351	13,931	4.98
2012	667	14,738	5.12

Table 2. Measures of illness severity over time

	2006	2007	2008	2009	2010	2011	2012	*P*
Requiring inpatient services	180 (28.9%)	161 (31.2%)	117 (34.8%)	120 (39.1%)	174 (44.4%)	167 (47.5%)	334 (50.0%)	<.001
Mean length of stay (days)	3.12	3.44	3.79	4.28	4.63	5.82	7.35	<.001
Mean age of patient (years)	12.1	12.3	11.8	11.8	11.7	11.5	11.4	.006

the United States from 2006 to 2012. As seen in Table 1, the estimated national incidence and rate per 100,000 population did significantly increase over time. The incidence modestly increased over time, increasing from 4.28 per 100,000 population in 2006 to 5.12 per 100,000 population in 2012, $P = .019$.

However, definitively, as seen in Table 2, the proportion of injuries requiring inpatient admission (28.9% in 2006 to 50.0% in 2012, $P < .001$) and mean LOS in the hospital (3.12 days in 2006 to 7.35 days in 2012, $P < .001$) significantly increased over time. The mean age decreased over time (12.1-year-old in 2006 to 11.4-year-old in 2012, $P = .006$).

CONCLUSION

The relaxing of U.S. fireworks laws may have had a modest effect on incidence of related injuries and the age of purchaser. However, it has had a dramatic effect on the severity of the related injuries, resulting in more inpatient admissions and longer LOS in the hospital. Preventative methods should be taken to reduce the rate and severity of firework-related injuries among U.S. youths.

In addition to the medical burden, an economic impact of fireworks is distinctly negative. Precautionary labeling and improved quality control has not been a sufficient approach to the prevention of pediatric firework-related burn injuries. Unfortunately, children represent half of fireworks injuries and may lack the capacity to read and follow label directions. It is advocated, and warranted, that the fireworks industry educates children about the dangers of fireworks.

The freedom to purchase explosive devices, including fireworks, is not one of the fundamental freedoms guaranteed by law. There are many safer ways of celebrating than exposing children to the dangers of the personal use of fireworks. In view of the incidence of injuries among children, a reevaluation of existing standards is warranted. In the absence of an effort on the national level, pediatricians can advocate similar restrictions in those states that still allow a wide variety of classes of fireworks to be purchased.

REFERENCES

1. Berger LR, Kalishman S, Rivara FP. Injuries from fireworks. Pediatrics 1985;75:877–82.
2. Kale D, Harwood B. Fireworks Injuries: US Consumer Product Safety Commission, 1979–1980. Washington, DC: US Consumer Product Safety Commission; 1980.
3. US Consumer Product Safety Commission. CPSC holds fireworks safety press conference on Mall in Washington [press release]. Washington, DC: US Consumer Product Safety Commission; June 28, 2000.
4. Greene MA. US Consumer Product Safety Commission, Directorate for Epidemiology and Health Sciences. Fireworks safety. Consumer Product Safety Review. 1999; 3:1–2.
5. Fireworks, SAS Estimates Report: Nationa lElectronic Injury Surveillance System Hazard Identification and Analysis. US Consumer Product Safety Commission, National Injury Information Clearinghouse, 1982.
6. Conkling JA. New federal standards for class C fireworks. Fire, May 1977, p 27.
7. Committee on Injury and Poison Prevention. Fireworks-related injuries to children. Pediatrics 2001;108:e558.
8. Agency for Healthcare Research and Quality. HCUP NIS Database Documentation. Healthcare Cost and Utilization Project (HCUP). Secondary HCUP NIS Database Documentation. Healthcare Cost and Utilization Project (HCUP) July 2014, 2014; available from www.hcup-us.ahrq.gov/db/nation/nis/nisdbdocumentation.jsp; accessed 21 Feb. 2016.
9. Agency for Healthcare Research and Quality. HCUP NEDS Database Documentation. Healthcare Cost and Utilization Project (HCUP). Secondary HCUP NEDS Database Documentation. Healthcare Cost and Utilization Project (HCUP) December 2014, 2014; available from www.hcup-us.ahrq.gov/db/nation/neds/nedsdbdocumentation.jsp; accessed 21 Feb. 2016.