ABSTRACT. Background. Approximately 32,000 nonpowder firearm injuries are reported annually with more than 60% occurring in the pediatric population. Case reports of serious and fatal injuries have been described; however, no large inclusive series have been published. We reviewed an 11-year experience of an urban pediatric emergency department to evaluate the circumstances, spectrum of injuries, and outcomes attributable to nonpowder firearms.

Methods. A retrospective, descriptive case series of all children 18 years of age or younger evaluated at an urban children’s hospital from January 1983 through December 1994 were eligible for study. Patients were identified using a computerized database, the National Electronic Injury Surveillance System, and the trauma registry in the department of surgery. Medical records were reviewed to collect demographic information, circumstances of injury, anatomic site and type of injury, treatment, and outcomes for nonpowder firearm injuries.

Results. One hundred eighty patients were identified, and a complete data set was available for 166 (92%). The mean age was 12 ± 3.7 years, 24% of children were <10 years old, and 71% of the children were male. Three patients returned with a second nonpowder firearm injury during the study period. Forty-nine percent of injuries were intentional and 44% of all injuries occurred during the summer and early fall months. The most common sites of injury were the extremity/buttocks (39%), head and neck (33%), thorax (15%), and eye (8%). Serious injuries included intracranial hemorrhage, cardiac right ventricle laceration, hyphema, and abdominal visceral injury (liver laceration, pancreatic laceration, intestinal perforation). The majority of wounds required local wound care, and the children (74%) were discharged from the emergency department. Of the patients admitted to the hospital (27%), 45% required operative intervention. There were no deaths. Seven percent (12/166) of patients sustained some functional deficit with 42% (5/12) the result of an ocular injury.

Conclusion. The majority of nonpowder firearm injuries are minor; however, the potential for serious injury should not be underestimated. Minor injuries can be treated with local wound care and tetanus prophylaxis, and patients can be discharged from the emergency department. Education of parents and children to the potential risks associated with these weapons is essential. Stricter regulations regarding ownership of nonpowder firearms and mandatory safety instruction should be considered. Pediatrics 1997;100(4). URL: http://www.pediatrics.org/cgi/content/full/100/4/e5; firearms, wounds, violence, child.

ABBREVIATION. NEISS, National Electronic Injury Surveillance System.

Increasingly, attention has been focused on the epidemic of firearm-related injuries in the pediatric population, which carries a mortality rate of 12% to 19%.1–3 What often escapes mention are the estimated 32,000 injuries attributable to nonpowder firearms (ie, BB gun, pellet gun, and air rifle) which occur each year in the United States.1 The majority of victims (more than three quarters) are under the age of 15. This is particularly disturbing because most states have minimal or no restrictions on the sale and use of these weapons to children. In fact, only 14 states in the United States have legislation governing the sale or possession of these weapons.1

Many case reports of serious and even fatal nonpowder firearm injuries have been published describing ocular, intracranial, abdominal, and thoracic wounds.4–20 yet there is little data regarding the epidemiology and outcome in a defined population. We reviewed all nonpowder firearm injuries treated at an urban pediatric hospital during an 11-year period to ascertain demographic characteristics, specific injuries, and outcomes.

METHODS

All nonpowder firearm injuries treated in the Children’s Hospital of Philadelphia emergency department were identified for the period 1983 to 1994 using data from the National Electronic Injury Surveillance System (NEISS) under the auspices of the US Consumer Product Safety Commission. NEISS includes data from 91 hospitals that were selected as a representative sample of approximately 6000 hospitals with emergency departments in the United States. Our institution is one of the participating hospitals that provide data to the NEISS and a listing of these patients was provided by them. Additional patients who had been transported by ground or air and diverted from the emergency department were identified using the trauma registry from the department of surgery. This included patients from 1986 through 1994.

Abstraction of information included the following: demographic information such as month/year of injury; patient age, race, and gender; circumstances of injury; anatomic location of injury; diagnostic studies; treatment; and outcome including delayed complications, functional deficits (defined as persistent alteration in the ability to perform activities of daily living), and mortality. A random sample (approximately 15%) of medical
RESULTS

During the 11-year period, 180 patients were identified as having sustained a nonpowder firearm injury (157 via NEISS, 23 via trauma registry). Medical records were reviewed, and a complete data set was available for 166 (92%). These patients formed the study population for all reported data. In a random sample of 15% of charts, reabstraction revealed more than 95% concordance of original abstracted data.

The highest rate of injury (45%) occurred during the summer and early fall months (July through October) (Fig 1). The mean age was 12 ± 3.7 years (range, 2 to 18 years) and the highest prevalence of injury was observed in the 10- to 14-year age group (54%). Eight percent of the children injured were under 5 years of age (Table 1). Most children sustained a single wound; however, up to four wounds were reported. Overall, 49% of injuries were intentional and were the direct result of an assault. Most injuries (77%) occurred outside the home.

The most common sites of injury were the extremities (39%), head and neck (33%), thorax (13%), and eye (8%) with insignificant variability based on age (Table 2). Evaluation and treatment of the patients included: laboratory tests (17%), radiographic imaging (either plain radiography or computed tomography scan) (59%), antibiotic prophylaxis (22%), and tetanus booster (25%). Specific wound therapy included wound irrigation (30%), removal of foreign body (17%), and operative intervention (12%).

The majority of patients (74%) were treated and discharged from the emergency department (P < .001) (Table 3). Of the 27% of patients admitted to the hospital for their injuries, 45% required an operative procedure. The most common injuries requiring either hospitalization or operative intervention were injuries to the eye (40%), abdomen (15%), and neck (15%) (Table 4). There was a significant association among ocular and abdominal injuries requiring hospitalization or operative intervention when compared with all other injuries (ocular odds ratio, 44.5; 95% confidence interval 6, 951; P < .001; abdomen odds ratio, 11.8; 95% confidence interval 1.2, 285; P = .02). Seven percent of patients sustained some degree of functional deficit, including loss of vision and severe neurologic impairment, and there was a single late complication (wound infection). No deaths (0% with 95% confidence interval, 0 to 2%) occurred in this series. Three patients returned with a second nonpowder firearm-related injury within the study period.

DISCUSSION

Nonpowder firearms represent a significant source of injury in the pediatric age group in this country. There are two injury patterns that result from nonpowder firearms: minor, requiring local care in the emergency department with subsequent discharge; and serious, requiring admission to the hospital and frequently operative intervention. Serious injuries occasionally cause long-term functional deficit. Nonpowder firearms can generate muzzle velocities of 200 to 900 foot-pounds per second; skin penetration requires only 120 foot-pounds per second. Fortunately, the majority of these injuries are minor (74% in this series).

The potential for serious injury, however, mandates that all nonpowder firearm wounds be thoroughly evaluated to avoid missing underlying severe injury. This should include localization of the foreign body, if present, in three dimensions using imaging techniques (typically roentgenograms), determination of the trajectory to postulate potential organs injured, and assessment of the need for operative intervention. Wounds determined to be minor should receive local wound care (irrigation, removal of foreign body if superficial), and tetanus prophylaxis. Antibiotics are not required routinely, but their use should be at the discretion of the treating physician. Antibiotics are typically reserved for patients with additional risk factors for wound infection (ie, tissue devitalization, delay in treatment, or gross contamination). Patients with potentially serious wounds should be admitted for observation and, if indicated, operative intervention.

In this series, extremity injuries were most common and the least likely to require admission. Typically these wounds required only local wound care, careful neurovascular evaluation, and tetanus prophylaxis if boostering is necessary. Ocular injuries, in contrast, occur less frequently but account for 28% of admissions, have frequent residual functional deficits (42%), and require operative intervention in 62%. This is in accordance with the consequences of nonpowder firearm ocular injuries previously reported. Although abdominal injury occurred in only 3% in this population, 80% of those patients required hospitalization and/or operative intervention. In our
TABLE 2. Age-specific Injuries by Anatomic Site

<table>
<thead>
<tr>
<th>Age Group (Years)</th>
<th>Head/Neck</th>
<th>Eye</th>
<th>Face</th>
<th>Thorax</th>
<th>Abdomen</th>
<th>Extremity</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–4</td>
<td>6 (43)</td>
<td>1 (7)</td>
<td>3 (21)</td>
<td>0</td>
<td>2 (14)</td>
<td>2 (14)</td>
</tr>
<tr>
<td>5–9</td>
<td>8 (31)</td>
<td>2 (8)</td>
<td>6 (23)</td>
<td>2 (8)</td>
<td>6 (23)</td>
<td>44 (49)</td>
</tr>
<tr>
<td>10–14</td>
<td>30 (33)</td>
<td>6 (7)</td>
<td>1 (1)</td>
<td>9 (10)</td>
<td>0</td>
<td>13 (36)</td>
</tr>
<tr>
<td>15–18</td>
<td>10 (28)</td>
<td>4 (11)</td>
<td>1 (3)</td>
<td>7 (19)</td>
<td>1 (3)</td>
<td>22 (13)</td>
</tr>
<tr>
<td>Total (%)</td>
<td>54 (33)</td>
<td>14 (8)</td>
<td>7 (4)</td>
<td>22 (13)</td>
<td>5 (3)</td>
<td>65 (39)</td>
</tr>
</tbody>
</table>

TABLE 3. Disposition and Outcome of Children With Non-powder Firearm Injuries

<table>
<thead>
<tr>
<th>No. of Patients</th>
<th>% (95% Confidence Interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency department discharge disposition</td>
<td>Head/Neck</td>
</tr>
<tr>
<td>Not hospitalized</td>
<td>122</td>
</tr>
<tr>
<td>Hospitalized</td>
<td>24</td>
</tr>
<tr>
<td>Hospitalized with operating room intervention</td>
<td>20</td>
</tr>
<tr>
<td>Outcome</td>
<td>153</td>
</tr>
<tr>
<td>No deficits</td>
<td>12</td>
</tr>
<tr>
<td>Functional deficit</td>
<td>1</td>
</tr>
<tr>
<td>Late complication</td>
<td>1</td>
</tr>
<tr>
<td>Death</td>
<td>0</td>
</tr>
</tbody>
</table>

TABLE 4. Disposition Based on Body Part Injury

<table>
<thead>
<tr>
<th>Body Site</th>
<th>No. of Patients (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Discharge</td>
</tr>
<tr>
<td>Head/neck</td>
<td>40 (74)</td>
</tr>
<tr>
<td>Ocular</td>
<td>1 (8)</td>
</tr>
<tr>
<td>Thorax</td>
<td>16 (73)</td>
</tr>
<tr>
<td>Abdomen</td>
<td>1 (20)</td>
</tr>
<tr>
<td>Extremity</td>
<td>58 (89)</td>
</tr>
</tbody>
</table>

population, the odds of requiring admission for ocular or abdominal injuries were substantial. Thoracic injury occurred in 13% of patients and required operative intervention in 5%. The potential lethal nature of these wounds is evidenced by the child who sustained right ventricular penetration and presented with pericardial tamponade. Others have had similar experiences including cardiac penetration with pellet embolization and aortic penetration with delayed cardiac arrest and death. Infracranial penetration of the pellet is also a possibility with its attendant risk of morbidity and mortality. Our series included a child with intracranial penetration and associated subarachnoid hemorrhage and residual aphasia related to injury to the temporal lobe of the brain.

Although deaths attributable to nonpowder firearms have been reported in previous case reports, there were no deaths in this series. The lethal potential of these wounds is difficult to quantify due to the paucity of large reported series; however, this should not diminish the concern in the evaluation of these patients. Projectiles fired from modern carbon dioxide-powered rifles can achieve a muzzle velocity of more than 900 foot-pounds per second, comparable to most handguns.

Education of the public as to the wounding capacity of these weapons is essential. Traditionally, these firearms are owned by adolescents who believe that nonpowder firearms are little more than toys. Wounds created by these weapons should be regarded as potentially serious as powder firearm injuries. As has been suggested by Powell et al, unless we embrace and integrate a public health approach to reduce these violent injuries and participate proactively in the legislative process, we will continue to witness preventable injuries and death from nonpowder firearms in children.

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Pediatric Nonpowder Firearm Injuries: Outcomes in an Urban Pediatric Setting
Philip V. Scribano, Michael Nance, Patrick Reilly, Ronald F. Sing and Steven M. Selbst

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DOI: 10.1542/peds.100.4.e5

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