Word cloud of the frequency of breeds identified in serious dog bite injuries in a 4-year review of 1616 consecutive dog bite injuries treated at Children’s Healthcare of Atlanta (CHOA), a level I trauma center.

Opposition to Senate Bills 741 & 709

Senate Judiciary Committee
Michigan State Senate
February 20, 2018
Written Testimony by DogsBite.org

Source of graphic:
Characteristics of 1616 Consecutive Dog Bite Injuries at a Single Institution, by Michael S. Golinko, MD, MA, Brian Arslanian, MD2, and Joseph K. Williams, MD, FAAP, Clinical Pediatrics, July 2016
Written Testimony by DogsBite.org

DogsBite.org is 501(c)(3) national dog bite victims’ advocacy organization dedicated to reducing serious dog attacks.

Senate Judiciary Committee
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Opposition to Senate Bill 741
Opposition to Senate Bill 709

Strike the Section 7 “Breed-Specific Law Preemption” in SB 709

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Mortality, Mauling, and Maiming by Vicious Dogs, by John K. Bini, MD, Stephen M. Cohn, MD, Shirley M. Acosta, RN, Marilyn J. McFarland, RN, MS, Mark T. Muir, MD and Joel E. Michalek, PhD; for the TRISAT Clinical Trials Group, Annals of Surgery, April 2011 - Volume 253 - Issue 4 - p 791–797

DogsBite.org is a national dog bite victims’ group dedicated to reducing serious dog attacks. Through our work, we hope to protect both people and pets from future attacks. Our website contains a wide collection of data to help policy-makers and citizens learn about dangerous dogs. Our research focuses on pit bull type dogs. Due to selective breeding practices that emphasize aggression and tenacity, this class of dogs negatively impacts communities the most.

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Summary of Key Peer-Reviewed Medical Studies (2011-2016)

There are nearly a dozen peer-reviewed medical studies published in medical science publications since 2011 that show similar results in retrospective reviews of level I trauma centers for dog bite injuries. Their findings show a higher frequency of pit bull injuries than other breeds of dogs. The majority of these studies also found that compared with attacks by other breeds of dogs, attacks by pit bulls are associated to a higher severity of injuries and higher hospital charges. This is a growing body of studies. Doctors continue to find these same shared results.

For brevity we are including three recent key studies. The first, Characteristics of 1616 Consecutive Dog Bite Injuries at a Single Institution (2016), is a 4-year review of Children’s Healthcare of Atlanta (CHOA), the only pediatric level I trauma center in Georgia. The study refers back to eight different medical studies (starting in 2000). Their findings are consistent with six of them regarding pit bull injuries compared to other dog breeds: higher frequency, higher severity and higher costs.

Our data confirm what detractors of the breed and child advocates suggest—that, with rare exceptions, children and pit bulls do not mix well. Of the 8 studies listed in Table 5, 6 report pit bulls as the most prevalent breed, and in many cases, they inflicted the most severe injuries. A large study at Children’s Hospital of Pennsylvania showed that over a 12-year period, 25% of injuries were caused by a pit bull, and two-thirds of those required an operation. Our data were consistent with others, in that an operative intervention was more than 3 times as likely to be associated with a pit bull injury than with any other breed. Half of the operations performed on children in this study as well as the only mortality resulted from a pit bull injury. Our data revealed that pit bull breeds were more than 2.5 times as likely as other breeds to bite in multiple anatomical locations. Although other breeds may bite with the same or higher frequency, the injury that a pit bull inflicts per bite is often more severe. Consistent with these findings is that of Bini et al, who reported on 228 patients and found that attacks by pit bulls resulted in a higher injury severity score, lower Glasgow coma score, higher risk of death, and higher hospital charges than attacks by any other breed.

The second study, Dog Bites of the Head and Neck: An Evaluation of a Common Pediatric Trauma and Associated Treatment (2015), is a review of 334 dog bite cases from the University of California Davis Medical Center, a level I trauma center in Sacramento. The study shows a higher frequency of pit bull injuries, a higher degree of severity injuries -- 5 times the relative rate of surgical interventions -- compared to
other dog breeds. The authors also state, “The key finding from our second objective, determining the dogs responsible for bites, is the importance of pit bull terriers in patients with dog bites of the head and neck. The findings of this study are consistent with and extend from previous publications [5,7,11–13,16,21,22,29].”

**Results:** 334 unique dog bites were identified, of which 101 involved the head and neck. The mean patient age was 15.1 ± 18.1 years. Of the more than 8 different breeds identified, one-third were caused by pit bull terriers and resulted in the highest rate of consultation (94%) and had 5 times the relative rate of surgical intervention. Unlike all other breeds, pit bull terriers were relatively more likely to attack an unknown individual (+31%), and without provocation (+48%). Injuries of the head and neck had an average follow-up of 1.26 ± 2.4 visits, and average specialty follow-up of 3.1 ± 3.5 visits.

**Conclusions:** The patients most likely to suffer dog bite injuries of the head and neck are children. Although a number of dog breeds were identified, the largest group were pit bull terriers, whose resultant injuries were more severe and resulted from unprovoked, unknown dogs. More severe injuries required a greater number of interventions, a greater number of inpatient physicians, and more outpatient follow-up encounters.

The final study, Mortality, Mauling, and Maiming by Vicious Dogs (2011), is a retrospective review of all dog bite cases admitted into the level I trauma center at University Hospital San Antonio from 1994 to 2009 and treated by the Trauma and Emergency Surgery Service. The examination of these cases showed that compared to attacks by other breeds of dogs, attacks by pit bulls had a higher degree of severity of injury, higher median hospital charges and a higher risk of death.

**Results:** Our Trauma and Emergency Surgery Services treated 228 patients with dog bite injuries; for 82 of those patients, the breed of dog involved was recorded (29 were injured by pit bulls). Compared with attacks by other breeds of dogs, attacks by pit bulls were associated with a higher median Injury Severity Scale score (4 vs. 1; \(P = 0.002\)), a higher risk of an admission Glasgow Coma Scale score of 8 or lower (17.2% vs. 0%; \(P = 0.006\)), higher median hospital charges ($10,500 vs. $7200; \(P = 0.003\)), and a higher risk of death (10.3% vs. 0%; \(P = 0.041\)).

**Conclusions:** Attacks by pit bulls are associated with higher morbidity rates, higher hospital charges, and a higher risk of death than are attacks by other breeds of dogs. Strict regulation of pit bulls may substantially reduce the US mortality rates related to dog bites.
Characteristics of 1616 Consecutive Dog Bite Injuries at a Single Institution

Michael S. Golinko, MD, MA1, Brian Arslanian, MD2, and Joseph K. Williams, MD, FAAP2,3

Abstract
Dog bite injuries remain a common form of pediatric trauma. This single-institution study of 1616 consecutive dog bite injuries over 4 years revealed a much higher prevalence of dog bites as compared with other similar centers. Though inpatient admission was rare (9.8%), 58% of all patients required laceration repair, primarily in the emergency department. Infants were more than 4 times as likely to be bitten by the family dog and more than 6 times as likely to be bitten in the head/neck region. Children ≤5 years old were 62% more likely to require repair; and 5.5% of all patients required an operation. Pit bull bites were implicated in half of all surgeries performed and over 2.5 times as likely to bite in multiple anatomic locations as compared to other breeds. The relatively high regional prevalence and younger age of injured patients as compared with other centers is a topic of further study but should draw attention to interventions that can minimize child risk.

Keywords
dog bite injury, pediatric trauma, repair of dog bites

Introduction
Dog bite repairs were among the top 5 reconstructive procedures performed by plastic surgeons, and this number, nearly 27000 annual repairs, exceeded head/neck and lower-extremity reconstruction.1 The management of dog bite injuries range from simple washouts and laceration repair to more complex procedures such as craniotomies or replantation. Interestingly, the first partial face transplant was performed on a woman who had been attacked by her Labrador.2,3

From reviewing the statistics in Table 1, it is likely that plastic surgeons interact with only a small fraction of patients who have been injured by a dog and often the most severe. It is emergency department (ED) physicians, pediatricians, primary care providers, and parents, however, who are the vital frontline in education, treatment, and prevention regarding dog bite injuries.

Although precautions can be taken to prevent injury, the trends in the personal and financial cost of dog bite injuries have only increased in recent years. There was an 86% increase in hospitalizations from 1993 to 2008 and an 82% increase in fatal dog attacks from the 1980s to 2012.10 Paid homeowners’ insurance claims too have increased from $324 to $478 million in just 8 years.12

This study stemmed from the high prevalence of dog bite injuries treated at our pediatric tertiary hospital, with an aim to quantify the scope of the problem and identify potential targets of intervention for primary care providers. For surgeons managing extremity and facial trauma, the ultimate goal is to reduce the amount of severe injury encountered by drawing both clinician and lay attention to what may be a preventable threat to children’s safety.

Methods
After institutional review board approval, a 4-year retrospective chart review was conducted from ED charts at the Children’s Healthcare of Atlanta (CHOA), the only pediatric level I trauma center in the state. Inclusion criteria were the following: patients <20 years old, male or female, initial triage in the CHOA ED for a dog bite or transfer from another center where primary treatment had not been performed. Table 1 shows summary statistics for the study group.

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Table 1. Recent Statistics on Dog Bite Injuries.

- 83.3 Million dogs living in more than 50 million households
- 4.5 Million annual dog bites; ~885,000 require medical attention; ~400,000 treated in the ED
- 64.9% Of bites are to the head and neck
- Most prevalent age group: 5-9 years old
- Up to 50% of children may develop posttraumatic stress disorder
- 55.6% Of all mortalities occur in children <10 years old
- 78% Of all deaths from dog attacks between 2005 and 2013 were from pit bulls and Rottweilers

Table 2. Patient- and Dog-Related Outcome Variables.

<table>
<thead>
<tr>
<th>Patient Variables</th>
<th>Value (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients</td>
<td>1616</td>
</tr>
<tr>
<td>Percentage male</td>
<td>56.3%</td>
</tr>
<tr>
<td>Percentage female</td>
<td>43.7%</td>
</tr>
<tr>
<td>Patient age group</td>
<td>6.8 Years (5 days to 20 years)</td>
</tr>
<tr>
<td>0-1 Years old</td>
<td>144 (8.9)</td>
</tr>
<tr>
<td>1-5 Years old</td>
<td>428 (26.5)</td>
</tr>
<tr>
<td>5-12 Years old</td>
<td>808 (50.0)</td>
</tr>
<tr>
<td>&gt;12 Years old</td>
<td>236 (14.6)</td>
</tr>
<tr>
<td>City of bite identified</td>
<td>1296 (80.2)</td>
</tr>
<tr>
<td>Bite injury variables</td>
<td></td>
</tr>
<tr>
<td>Family dog</td>
<td>753 (46.6)</td>
</tr>
<tr>
<td>Known to the child (not family)</td>
<td>655 (40.5)</td>
</tr>
<tr>
<td>Unknown dog</td>
<td>205 (12.7)</td>
</tr>
<tr>
<td>Dog breeds identified</td>
<td>509 (31.3)</td>
</tr>
<tr>
<td>Anatomical area</td>
<td></td>
</tr>
<tr>
<td>Head/Neck</td>
<td>1004 (56.5)</td>
</tr>
<tr>
<td>Upper extremity</td>
<td>398 (22.4)</td>
</tr>
<tr>
<td>Lower extremity</td>
<td>252 (14.2)</td>
</tr>
<tr>
<td>Trunk</td>
<td>98 (5.5)</td>
</tr>
<tr>
<td>Other</td>
<td>25 (1.4)</td>
</tr>
</tbody>
</table>

Results

Triage Characteristics

A total of 1616 consecutive patients were included. Patients were bitten in 118 unique cities; however, in 320 (19.8%) cases, the city of bite could not be determined. Also, 10 patients (0.6%) were from out of state, and 192 patients (11.8%) were referred from, but not treated at, an outside facility.

As Table 2 summarizes, the majority of patients were young males of school age, and half of all patients were between 5 and 12 years of age. Approximately the same percentage of family dogs and dogs familiar to the child were implicated in injuries. Head and neck injuries (56.5%) were the most prevalent. It was found that 1477 (91.3%) children were bitten in 1 anatomical area, 98 (6.1%) in 2 areas, 31 (1.9%) in 3 areas, and 3 (0.1%) in 4 areas. Canine breed was identified by patient or family report in 31.3% of medical charts.

Of the 46 breeds identified, the 3 most prevalent were 38.5% pit bull (also identified as Staffordshire bull terrier, American Staffordshire terrier, or bull terrier), 13.0% mixed breeds, and 8.1% Labradors. Of the mixed breeds (n = 66), 11 were pit bull mixes, 12 Labrador mixes, and 4 Labrador/pit bull mixes. Figure 1 illustrates the relative frequency of biting breeds, with font size being a function of relative proportion.

Characteristics of Injury After Triage

Although more than 90% of patients were ultimately discharged, approximately 50% of those still required laceration repair. Approximately 10% of patients required inpatient admission, and 50% of those required an operation; 4.0% (n = 65) of patients returned to the ED with a soft-tissue infection (see Figure 2).

Age-Group Analysis

Contingency tables were calculated to compute the OR of the association of a specific age group or groups (risk...
factor) with the presence or absence of an injury characteristic—that is, injury in the head/neck area. OR regarding anatomical areas assumes the likelihood of at least 1 bite in each area. Table 3 illustrates these data, with statistically significant results in bold.

Of note, children 5 years old and younger were approximately 62% more likely to require repair in any setting and were between 3 and 6 times as likely to suffer a head and neck injury as compared with other groups. Infants were more than 4 times as likely to be bitten by the family dog and more than 6 times as likely to be bitten in the head/neck region. Lower-extremity injury correlated directly with age. Teenagers were more than twice as likely to sustain extremity injuries and be injured by an unknown dog or a pit bull. Bite injury to the lower extremity was statistically less likely in children younger than 5 years and more likely in children older than 5 years. Dog bites in more than 1 anatomical location was 1.7 times as likely in children 12 years and older as compared with all younger groups. No one age group was any more likely to require operative intervention than another.

**Features and Morbidity of Patients With the Most Severe Injuries**

In all, 5.5% (89) of patients underwent surgery; of these, 68.5% involved the head/neck region. Of the breeds identified, 50% involved pit bulls. The mean age was 6.3 years old (range = 5 days to 17 years). Table 4 enumerates the primary procedure performed.

With regard to breed, operative intervention was most strongly associated with a pit bull injury: OR = 3.361 (CI = 2.011-5.592); \( P < .001 \). Pit bull breeds were also more likely to bite in multiple anatomical locations, OR = 2.660 (CI = 1.598-4.436); \( P < .001 \). Four returns to the ED from this group were noted, including 2 for an abscess, 1 for exposed hardware, and 1 for wound necrosis. Known operative complications included the following: hand amputation after attempted revascularization, a growing skull fracture, and wound dehiscence with return to the operating room for skin graft placement.

The lone mortality involved a 5 day-old girl attacked on the head by the family’s pit bull. The child underwent emergency craniotomy. Her postoperative course was complicated by acute respiratory distress syndrome, neurogenic pulmonary edema, and transfusion-related acute lung injury. Despite maximal ventilator support, she was persistently hypoxic and succumbed on postoperative day 3.

**Discussion**

**Current Literature on Dog Bite Injuries**

Dog bite injuries are neither new nor an unstudied phenomenon in children. Table 5 summarizes some of the recent literature emerging from pediatric centers comparable to our own.

On average, the centers cited saw approximately 120 dog bite injuries per year, per institution (range between 17 and 204 per year).\(^{18}\) Somewhat surprising was that our center averaged more than 400 patients per year. The relatively low population density of Georgia, allowing for larger dogs, and the scarcity of other pediatric trauma centers in the state may account for this high prevalence, but further detailed study is needed to see if dogs are truly biting at a higher rate. There are significant gaps in the literature, as Table 5 illustrates, including detailed data on the biting dog, disposition of the child after ED triage, age in relation to multiple variables, frequency and type of repair, and types of operations performed.

**Age and Injury Patterns**

The largest ED survey published found that boys 5 to 9 years old\(^{21}\) are most susceptible to bite injury. In addition to domestic studies, the world literature is clear: in reports from Canada,\(^{22}\) Spain,\(^{23}\) Austria,\(^{24}\) South Africa,\(^{13}\) Australia,\(^{25}\) Peru,\(^{26}\) India,\(^{27}\) Hong Kong,\(^{28}\) and Bhutan,\(^{29}\) persons younger than 18 years are most at risk for dog bite injury. Our study certainly was consistent with others’ findings; however, a breakdown into clinically significant age categories provided some new findings.

The age-group analysis in this study indicates that younger children than previously thought are more at risk for injury. Infants (≤1 year old), more so than any
other age group in this study, were most likely to suffer a head/neck injury and be bitten by the family dog or a dog the family knows, and least likely to be bitten by an unknown dog. This was a surprising finding given that most literature points to older children being more susceptible. Moreover, the one mortality in this study of a 5-day old baby girl attacked by her family pit bull should be sobering evidence enough to exercise extreme caution in this age group when in contact with that particular breed. Children younger than 5 years were nearly half as likely to suffer an extremity injury, whereas children older than 12 years were over twice as likely to. These trends may not be merely a matter of total body surface area and height, but also age-specific behavior of children toward dogs—that is, young children kissing or nuzzling the dog and older children playing catch, feeding, washing, or petting.

Although the data seem to support a common sense assumption, knowledge of this propensity can guide parents when supervising their young children in the presence of the family pet. A Dog You Know

Unfortunately, familiarity may lead to injury. The existing literature reveals that the family dog inflicts injury between 27% and 45% of the time, more so than a neighbor’s dog or a stray. Some studies we reviewed, however, did not distinguish between a dog known to the family, such as a neighbor’s dog, and the family dog. This is a potentially important distinction because we suspect that the more parents (and children) are familiar with a dog, the less vigilant they may be. Our data were consistent with others findings that the family dog was statistically no more likely to be involved in a bite injury than a familiar dog, however: 46.6% and 40.5%, respectively (P > .05), and again, infants were most at risk in each of these categories. Whether this finding is indicative of parents’ level of supervision around the family dog or whether it is simply because children have more chances to be bitten by the family dog as compared with a dog that is not routinely around, we interpret the data to indicate that parents should demonstrate equal vigilance in all cases. Indeed, in one study of 56 modifiable risk factors, the strongest was “the absence of an able-bodied person to intervene”—present in more than 87% of injuries reviewed.

**Pit Bull Injuries**

Our data confirm what detractors of the breed and child advocates suggest—that, with rare exceptions, children and pit bulls do not mix well. Of the 8 studies listed in Table 5, 6 report pit bulls as the most prevalent breed, and in many cases, they inflicted the most severe injuries. A large study at Children’s Hospital of Pennsylvania showed that over a 12-year period, 25% of injuries were caused by a pit bull, and two-thirds of those required an operation. Our data were consistent with others, in that an operative intervention was more than 3 times as likely to be associated with a pit bull injury than with any other breed. Half of the operations performed on children in this study as well as the only mortality resulted from a pit bull injury. Our data revealed that pit bull breeds were more than 2.5 times as likely per bite to be involved in a bite injury than a familiar dog, however: 46.6% and 40.5%, respectively (P > .05), and again, infants were most at risk in each of these categories. Whether this finding is indicative of parents’ level of supervision around the family dog or whether it is simply because children have more chances to be bitten by the family dog as compared with a dog that is not routinely around, we interpret the data to indicate that parents should demonstrate equal vigilance in all cases. Indeed, in one study of 56 modifiable risk factors, the strongest was “the absence of an able-bodied person to intervene”—present in more than 87% of injuries reviewed.

**The High-Risk Animal: A Dog You Know**

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Table 3. Characteristics by Age Group, as Percentage of the Total in Each Group.\textsuperscript{a}

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>0 to ≤ 1.0 Year Old (144)</th>
<th>1.0 &lt; Age ≤ 5.0 Years Old (533)</th>
<th>5.0 &lt; Age ≤ 12.0 Years Old (746)</th>
<th>&lt;12.0 Years Old (193)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (%) OR (CI), P Value</td>
<td>n (%) OR (CI), P Value</td>
<td>n (%) OR (CI), P Value</td>
<td>n (%) OR (CI), P Value</td>
</tr>
<tr>
<td>Head/Neck injury</td>
<td>109 (75.7) 6.197 (4.122-9.350)</td>
<td>389 (73.0) 3.043 (2.429-3.816)</td>
<td>420 (56.3) 0.991 (0.816-1.204)</td>
<td>87 (45.1) 1.194 (0.879-1.622)</td>
</tr>
<tr>
<td>Upper extremity</td>
<td>25 (17.4) 0.962 (0.559-1.536)</td>
<td>102 (19.1) 0.784 (0.605-1.017)</td>
<td>201 (26.9) 1.252 (0.992-1.581)</td>
<td>70 (36.3) 2.348 (1.688-3.263)</td>
</tr>
<tr>
<td>Lower extremity</td>
<td>9 (6.3) 0.452 (0.212-0.930)</td>
<td>50 (9.4) 0.529 (0.376-0.743)</td>
<td>145 (19.4) 1.252 (0.992-1.581)</td>
<td>48 (24.9) 2.231 (1.535-3.238)</td>
</tr>
<tr>
<td>Trunk</td>
<td>8 (5.6) 1.118 (0.489-2.458)</td>
<td>24 (4.5) 0.675 (0.409-1.106)</td>
<td>73 (9.8) 1.310 (0.911-1.883)</td>
<td>24 (12.4) 1.728 (1.052-2.819)</td>
</tr>
<tr>
<td>Other</td>
<td>1 (0.7) 0.468 (0.023-3.288)</td>
<td>5 (0.9) 0.510 (0.167-1.448)</td>
<td>14 (1.8) 1.488 (0.632-3.531)</td>
<td>5 (2.6) 5.657 (2.7-11.789)</td>
</tr>
<tr>
<td>≥2 Anatomical areas</td>
<td>10 (6.9) 0.846 (0.408-1.703), P = .749</td>
<td>32 (6.0) 0.627 (0.408-0.961)</td>
<td>73 (9.8) 1.310 (0.911-1.883)</td>
<td>24 (12.4) 1.728 (1.052-2.819)</td>
</tr>
<tr>
<td>Operative repair</td>
<td>9 (6.3) 1.219 (0.558-2.576)</td>
<td>25 (5.8) 1.364 (0.860-2.160)</td>
<td>48 (5.9) 0.960 (0.611-1.506)</td>
<td>7 (3.0) 0.449 (0.158-1.167)</td>
</tr>
<tr>
<td>Family dog</td>
<td>97 (67.4) 4.326 (2.973-6.305)</td>
<td>264 (49.5) 1.644 (1.334-2.025)</td>
<td>306 (41.0) 0.877 (0.721-1.068), P = .188</td>
<td>86 (44.6) 1.611 (1.182-2.195)</td>
</tr>
<tr>
<td>Known dog</td>
<td>38 (26.4) 1.617 (1.074-2.427)</td>
<td>206 (39.2) 1.228 (0.992-1.520)</td>
<td>338 (45.3) 1.386 (1.129-1.702)</td>
<td>74 (38.3) 1.441 (1.049-1.979)</td>
</tr>
<tr>
<td>Unknown dog</td>
<td>9 (6.3) 0.498 (0.233-1.026)</td>
<td>62 (11.6) 0.940 (0.676-1.306)</td>
<td>101 (13.5) 1.158 (0.855-1.569)</td>
<td>33 (13.5) 1.667 (1.086-2.548)</td>
</tr>
<tr>
<td>Pit bull injury</td>
<td>15 (10.4) 0.952 (0.523-1.706)</td>
<td>48 (9.0) 0.706 (0.493-1.009)</td>
<td>99 (13.2) 1.255 (0.919-1.715)</td>
<td>31 (16.1) 1.644 (1.059-2.541)</td>
</tr>
</tbody>
</table>

\textsuperscript{a}Odds ratios (ORs) are reported, calculated with age as the independent variable. Confidence intervals are reported; those that are statistically significant, with \( P < .05 \), are in bold.
Glasgow coma score, higher risk of death, and higher hospital charges than attacks by any other breed.\textsuperscript{17}

**Morbidity of Dog Bite Injuries**

Whereas existing studies focus on only bites repaired in the ED or only the most severe requiring the OR, this study sought to follow patients longitudinally throughout their course from triage to treatment and disposition. Summarizing from Table 5, national admission rates range between 6.4\%\textsuperscript{15} and 22.5\%,\textsuperscript{16} and operative rates range between 3.1\%\textsuperscript{15} and 25.2\%.\textsuperscript{20} This study revealed that 57.9\% of patients required some form of repair following a dog bite, 9.8\% of patients required inpatient admission, and more than 50\% of admissions were associated with an operation. Younger children (mean age = 6.3 years) tended to require an operation. Although the majority of injuries required only washout and closure, revascularization of the hands, ORIF of long bones, and craniotomies were among the singular reminders of the severity of trauma a dog can inflict on a child; also, whereas the common laceration may not be preventable in many cases, these severe injuries often need not occur. Regardless of treatment setting, copious irrigation with betadine and saline, sharp debridement of any macerated or damaged tissues, deep closure with monocryl as needed, and loose skin approximation with permanent sutures, along with a 10-day course of amoxicillin/clavulanate potassium or clindamycin is advised. Families should be counseled that avoidance of secondary infection is more important in the short term than cosmesis because an unsightly scar can always be revised.

**Limitations and Bias**

Because this was a retrospective review of triage and medical record data, certain variables such as breed of dog could not be independently verified. There may be a reporting bias for typically “biting” breeds, such as pit bulls. Although 1616 consecutive children were included, 1608 of these were unique because 8 children were bitten at 2 separate time points and returned to the ED for treatment. Analysis of the same or different dog responsible for each bite was beyond the scope of this study but would be important to investigate. Another source of error is in the city of bite because data recorded where the bite took place may not necessarily be where the animal normally resides. Often, bites occurred at home, for which data would be accurate. Comparison of admission, ED, and surgical repair rates are biased by institutional resources and local physician practice patterns. The authors acknowledge that etiology of a dog bite is complex and multifactorial, depending not only on the canine’s characteristics, but also on owner training, child behavior, and the specific conditions when the bite occurred. Operative complications and returns to the ED following a repair for a soft-tissue infection are likely underestimated as well because many patients may have sought care at their local physician’s office and not returned to the original point-of-service.

**Potential Public Health Interventions**

The health care providers who see the accidental and often deleterious effects of dog bite injury are vastly outnumbered by the heads of the approximately 56.7 million households\textsuperscript{34} who own dogs under the likely assumption that the dog will not harm them or their child. Several studies reflect this hypothesis\textsuperscript{35,36} and revealed that the majority of parents assumed that their infants were not at risk for an attack. As a Cochrane database review suggests, it is often better to educate the parents and pediatricians rather than children directly.\textsuperscript{37} Alarming, one survey of 254 parents revealed that only two-thirds believed that a dog could be the cause of a fatal infant injury.\textsuperscript{36}

At least in the United States, “man’s best friend” is part of the national psyche and is reinforced for children in the form of stuffed animals, cartoon characters, and animated movies. In this milieu, it is all the more important for any clinician, using data from this study and others, to caution parents appropriately about the potential hazards that specific canine situations may pose to their child. Inquiring and counseling about dogs at home and in the neighborhood should be as important and integral a part of any pediatric encounter, as would be cautioning.

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**Table 4. Frequency of Operative Procedures in 89 Patients Suffering Dog Bite Injuries.**

<table>
<thead>
<tr>
<th>Operating Room Procedure</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigation and closure</td>
<td>60 (65.9)</td>
</tr>
<tr>
<td>Canalicular repair</td>
<td>11 (12.1)</td>
</tr>
<tr>
<td>Wound irrigation and debridement</td>
<td>4 (4.4)</td>
</tr>
<tr>
<td>Cranietomy</td>
<td>3 (3.3)</td>
</tr>
<tr>
<td>Dural repair</td>
<td>2 (2.2)</td>
</tr>
<tr>
<td>Facial nerve repair</td>
<td>1 (1.1)</td>
</tr>
<tr>
<td>Local facial flap</td>
<td>1 (1.1)</td>
</tr>
<tr>
<td>ORIF humerus</td>
<td>1 (1.1)</td>
</tr>
<tr>
<td>ORIF mandible</td>
<td>1 (1.1)</td>
</tr>
<tr>
<td>ORIF radius</td>
<td>1 (1.1)</td>
</tr>
<tr>
<td>ORIF phalanx</td>
<td>1 (1.1)</td>
</tr>
<tr>
<td>Replant lip</td>
<td>1 (1.1)</td>
</tr>
<tr>
<td>Revascularization of hands</td>
<td>1 (1.1)</td>
</tr>
<tr>
<td>Tooth extraction</td>
<td>1 (1.1)</td>
</tr>
</tbody>
</table>

Abbreviation: ORIF, open reduction, internal fixation.
Table 5. Selected Studies of Dog Bite Injuries With Select Variables That Could Be Targets of Public Health Intervention.

<table>
<thead>
<tr>
<th>Authors (Year Published)</th>
<th>Study Length (years)</th>
<th>Patients (n)</th>
<th>City (Type of Site)</th>
<th>Two Most Prevalent Breeds Documented (%)</th>
<th>Percentage Family Dog</th>
<th>Percentage Familiar (But Not Family)</th>
<th>Percentage Unknown</th>
<th>Percentage Admitted/Operating Room</th>
<th>Mean or Most Prevalent Age Range (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dwyer et al, 2007</td>
<td>13</td>
<td>1871</td>
<td>Cape, Town South Africa (Children’s Hospital)</td>
<td>• PB 28% • GS 21% • 1%</td>
<td>37%</td>
<td>33%</td>
<td>7%</td>
<td>8.1%/4.5%</td>
<td>6.8 years old</td>
</tr>
<tr>
<td>Daniels et al, 2009</td>
<td>7</td>
<td>1347</td>
<td>Indianapolis, IN (2 children’s hospitals)</td>
<td>• PB 12% • GS 2.4% • 28% (inpatient only)</td>
<td>68.8% (Family + dog friend)</td>
<td></td>
<td></td>
<td>6.4%/3.1%</td>
<td>7.8 Years old (51%)</td>
</tr>
<tr>
<td>Kaye et al, 2009</td>
<td>5</td>
<td>551</td>
<td>Philadelphia, PA (children’s hospital)</td>
<td>• PB 50.9% • R 8.9% • 48.8%</td>
<td>89.8% (Family + dog friend)</td>
<td></td>
<td></td>
<td>6.8% Admit</td>
<td>6-12 Years old (51%)</td>
</tr>
<tr>
<td>Chen et al, 2013</td>
<td>5</td>
<td>537</td>
<td>Aurora, CO (children’s hospital)</td>
<td>• M 23% • L 13.7% • PB 35%</td>
<td>11.2% Admit</td>
<td></td>
<td></td>
<td>68% ≤ 5 Years old</td>
<td>21 Years old</td>
</tr>
<tr>
<td>Bini et al, 2011</td>
<td>15.5</td>
<td>228</td>
<td>San Antonio, TX (trauma hospital)</td>
<td>• PB 19% • GS 12% • 47%</td>
<td>72% (Family + dog friend)</td>
<td></td>
<td></td>
<td>6.8 Years old; &lt;5 Years: 49%</td>
<td></td>
</tr>
<tr>
<td>Bernardo et al,</td>
<td>1</td>
<td>204</td>
<td>Pittsburgh, PA (children’s hospital)</td>
<td>• PB 19% • GS 12% • 47%</td>
<td>27%</td>
<td>28%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reisner et al, 2011</td>
<td>3.5</td>
<td>203</td>
<td>Philadelphia, PA (children’s hospital)</td>
<td>• M 28% • PB 22%</td>
<td>72% (Family + dog friend)</td>
<td></td>
<td></td>
<td>9%</td>
<td>7.2 Years old</td>
</tr>
<tr>
<td>Wu et al, 2011</td>
<td>5</td>
<td>87</td>
<td>Springfield, MA (tertiary hospital)</td>
<td></td>
<td>25.2% OR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: PB, pit bull; GS, German Shepherd; R, Rottweiler Pincher/Rottweiler; M, mixed; L, Labrador.
For Parents:
- Determine what dogs live in the neighborhood and take appropriate precautions.
- Refrain from leaving children under 5-years-old unsupervised with a dog of any breed, family or otherwise.
- Never leave a child under 1 year-old alone with any dog.
- Exercise identical precautions when children are interacting with the family or a familiar dog.
- Dissuade or prevent children from behavior that brings their face in close proximity to the dogs.
- Avoid interacting with the dog when its’ eating, sleeping or nursing and allow their children to learn this habit.
- Strong consideration to avoidance of any interaction between pit bull breeds and young children, particularly infants.

For Primary Care Providers:
- Counsel parents as above, and that the #1 way to avoid accidental injury is supervision.
- Emphasize avoidance of secondary infection as opposed to cosmesis on in the initial repair.
- Have a low-threshold for surgical consult to ensure adequate irrigation and debridement under anesthesia.
- Routine patient encounters are an opportunity to inquire about any dog that children could routinely come in contact with, not just the family dog.

Figure 3. Select recommendations for primary care practitioners and parents based on study findings.

Conclusions
This is the first detailed study of dog bite injuries in Georgia and one of the largest studies conducted at a pediatric trauma center. Our study revealed that whereas more than half of all injuries necessitate repair, only approximately 5% require operative intervention. The data also suggest that younger children (<5 years old) than previously reported, and particularly infants, are at high risk for the most severe injuries. The study corroborates the largely negative interactions between pit bulls and children of any age. Parental education and supervision may be the most important measure to prevent severe dog bite injuries.

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Author Contributions
MSG conceived the study idea and developed the research design with JKW. MSG wrote the initial drafts of the manuscript. MSG and BA spear-headed data collection, analysis and along with JKWwrote and edited all portions of the manuscript. JKW provided key insights and changes in discussion and data presentation.

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