

# Mortality, Mauling, and Maiming by Vicious Dogs

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**Objective:** Maiming and death due to dog bites are uncommon but preventable tragedies. We postulated that patients admitted to a level I trauma center with dog bites would have severe injuries and that the gravest injuries would be those caused by pit bulls.

**Design:** We reviewed the medical records of patients admitted to our level I trauma center with dog bites during a 15-year period. We determined the demographic characteristics of the patients, their outcomes, and the breed and characteristics of the dogs that caused the injuries.

**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.

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## CASE PRESENTATION

An 11-month-old boy arrived at our level I trauma center after being mauled by 2 pit bulls. The owner of the dogs was the infant's grandmother, who regularly cared for him in her home. Members of the community stated that the dogs were very protective of the owner, especially when outsiders approached the house. The grandmother had gone into the kitchen to get the infant a bottle, leaving him alone in the bedroom. The dogs were unattended in the house. When the grandmother returned to give the infant his bottle, she found the dogs attacking him. She attempted to pull the dogs off the infant, ultimately resorting to stabbing the dogs with a knife. They in turn attacked her. Emergency medical technicians arrived but were unable to rescue the infant from the dogs. Police were called to the scene and shot the dogs.

Upon arrival in the emergency department, the infant was undergoing cardiopulmonary resuscitation, and tracheal intubation had been performed. The infant had suffered multiple bites to the head, torso, and abdomen (Fig. 1). The wounds included a scalp degloving injury and a deep puncture wound to the right subclavian area. In

addition, there were multiple bites to the face, neck, chest, buttocks, and genital area. Bilateral chest tubes were placed, and blood products were rapidly infused. Despite maximal efforts, vital signs were not regained, and the infant was declared dead.

## INTRODUCTION

Dog bite injuries are a serious public health concern, affecting approximately 1.5% of the US population annually.<sup>1–3</sup> There are nearly 75 million dogs in the United States. The Centers for Disease Control and Prevention estimates that 885,000 people per year require medical attention for dog bites, although some investigators have suggested that the true incidence of dog bites is much higher than that reported (Table 1).<sup>4</sup> In 2006 alone, more than 31,000 patients required reconstructive surgery as the result of dog attacks.<sup>5</sup>

Fatal or near-fatal mauling by dogs is associated with a unique set of breed-specific characteristics that distinguish these attacks from less severe and nonlethal attacks. Historically, before the popularity of pit bulls began to increase, the breed did not account for most deaths related to dog attacks, even though the perbreed fatality rate showed that pit bulls were the leading killer.<sup>6–9</sup> Between 1966 and 1980, for example, although 16 deaths were attributable to German Shepherd Dogs and only 6 were attributable to pit bulls, there were 74,723 registered German Shepherd Dogs and only 929 registered pit bulls (includes American Pit Bull Terrier, the American Staffordshire Terrier, and the Staffordshire Bull Terrier).<sup>6,10</sup> This amounts to 0.2 deaths per 1000 German shepherds but 6.5 deaths per 1000 pit bulls (for a rate 33 times higher). As pit bulls have become more popular and their numbers have increased, so have the numbers of deaths attributable to their attacks. They now are the single breed responsible for the vast majority of deaths due to dog attacks (Table 2). In 2007, 33 fatal cases of dog mauling were reported in 17 states. Texas led the nation with 7 deaths, 6 of which were caused by pit bulls. In 2008 there were 23 fatal dog attacks, and pit bulls were responsible for 65% of these attacks and for all but 1 death due to dog attacks against persons aged more than 3 years.<sup>11,12</sup>

We postulated that patients admitted to a level I trauma center with dog bites would have severe injuries and that the gravest injuries would be those inflicted by pit bulls.

## METHODS

This was a retrospective review of cases of dog bites that required the patient to be admitted to our level I trauma center between January 1, 1994, and April 30, 2009. To find our study subjects, we reviewed the hospital's medical records and Trauma Registry. We queried the databases for all patients who were admitted to the Trauma and Emergency Surgery Service during the study period with International Classification of Diseases-9 codes indicating the diagnosis of animal bite by dog. In addition, we obtained information about the breed of attacking dog by reviewing animal injury reports at our city's Animal Care Services department. Patients were excluded from the study if they were not admitted to or treated by the Trauma and Emergency Surgery Service or if they were bitten by animals not considered to be dogs or dog hybrids. We obtained both a waiver of consent and a Health Insurance Portability and Accountability Act waiver of authorization from our university's Institutional Review Board.

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**FIGURE 1.** Small child fatally injured by 2 pit bulls. Note multiple wounds covering body, with deep wounds to buttock and head. The term *pit bull* refers to dogs from the following breeds: American Pit Bull Terrier, American Staffordshire Terrier, and Staffordshire Bull Terrier.

**TABLE 1.** National Dog Bite Demographics

**Key National Dog Bite Statistics**

- 74.8 million dogs in the United States
- 1.5% of US population is bitten every year (4.7 million)
- 885,000 persons per year require medical attention
- 31,000 persons per year require reconstructive surgery
- One of every 5 emergency room visits by children is related to dog bites
- 33 fatal dog bites in United States in 2007, most (7) in Texas. In contrast, California and New York each reported 1 dog bite fatality in 2007
- Median cost per admission for dog bite injuries is \$4569 (mean, \$7288)
- Cost of dog bites to home insurers in 2007 was \$356.2 million
- Total losses related to dog bites may exceed \$1 billion per year

Adapted from References (Sacks, Kresnow et al. 1996;<sup>7</sup> Voelker 1997;<sup>1</sup> Weiss, Friedman et al. 1998;<sup>2</sup> CDC 2001;<sup>3</sup> CDC 2003; www.dogsbite.org <http://www.dogsbite.org>. Dogsbite.org anuary 3, 2009; www.dogsbite.org <http://www.dogsbite.org>. <http://www.youtube.com/watch?v=X8nVTctxUDE> October 25, 2008).

We collected information about the demographic characteristics of dog bite victims, their outcome, and their clinical course by reviewing hospital medical records, photographs, and radiographic results. In addition, we gathered information about the type and location of wounds and the severity of injury. We also determined, when possible, the characteristics of the attacking dog: breed; socialization information; attack provoked or unprovoked; whether dog was known to victim; location of attack; restraint applied to dog, if any; number of dogs involved in the attack; sex and sexual characteristics (neutered/spayed); rabies vaccination status; and whether dog was a trained attack, guard, or working dog. Finally, we reviewed hospital charges to assess the financial costs of these injuries.

We assigned all pit bulls breeds and pit bull hybrids to a category named *pit bull*, and we assigned dogs of other breeds to a category named *other breeds*. We used these breed categories to compare the characteristics of the victims, the characteristics of the attack, and the characteristics of the attacking dog. We summarized binary outcomes as counts and percents, and we summarized continuously distributed outcomes as mean and SD or median and range, as appropriate. We assessed the statistical significance of any differences associated with breed categories by using the Pearson chi-square test or the Fisher exact test for binary outcomes or by using analysis of variance or the Kruskal-Wallis test, as appropriate, for continuously

**TABLE 2.** Breed of Dog Associated With Involvement in Fatal Attacks, 2007 National Registration Data From the American Kennel Club, and Relative Risk of Fatal Attack\*

Breed†	Number of Dogs Involved in Fatal Attacks	Number of Dogs Registered AKC	Relative Risk of Fatal Attack Per Dog‡
Pit Bull‡	113	2239	2520
Neapolitan Mastiff	2	357	280
Chow Chow	2	1567	65
Rottweiler	18	14,211	65
Great Pyrenees	2	1916	50
Parson Russell Terrier	1	1096	45
Old English Sheepdog	1	1206	40
Siberian Husky	6	9048	35
Bullmastiff	1	3735	15
Doberman Pinscher	2	11,381	10
Australian Shepherd or Mix	1	6471	10
Mastiff Mix	1	7160	5
German Shepherd Dog	4	43,376	5
Boxer	1	33,548	1.5
Golden Retriever or Mix	1	39,659	1.5
Labrador Retriever or Mix <sup>2</sup>	2	114,110	1
Total	158		

Abbreviation: AKC, American Kennel Club.

\*Adapted from reference 14.

†Data presented only for dog breeds for which registration information is available from the American Kennel Club (AKC). The AKC does not register the Perro de Presa Canario, Wolf Hybrids, or dogs of unknown mixed breed.

‡The term *pit bull* refers to dogs from the following breeds: American Pit Bull Terrier, American Staffordshire Terrier, and Staffordshire Bull Terrier.

§Data for Labrador Retrievers and Labrador Mix are combined. Relative Risk is normalized to Labrador Retriever and Labrador Mix.

distributed outcomes. All statistical testing was 2-sided, and significance was assigned at the level of  $P = 0.05$ . SAS Version 9.1.3 for Windows (SAS Institute, Cary, NC) was used for all analyses.

**RESULTS**

During the 15-year period reviewed in this study, 228 dog bite injuries were treated by our Trauma and Emergency Surgery Service. Of the 228 attacks reviewed, the breed of dog was reported for 82 attacks. Of those 82 attacks, 29 (35%) were attributed to pit bulls and 53 (65%) were attributed to all other breeds of dogs combined.

**Characteristics of the Victims**

The mean age of the 228 victims of dog attacks was 21 years. Of persons attacked by dogs of known breed, those mauled by pit bulls ranged in age from 11 months to 90 years (mean, 28 years), whereas those attacked by dogs of all other breeds ranged in age from newborn to 69 years (mean, 16 years). The percentage of victims aged 18 years or older was higher for those attacked by pit bulls (51.7%) than for those attacked by other breeds (26.4%), but the age distributions did not vary significantly according to the breed category (Table 4;  $P = 0.096$ ). Additionally, there was no significant difference between the sex of victims attacked by pit bulls (male victims, 44.8%) and the sex of victims attacked by other breeds (male victims, 60.4%;  $P = 0.176$ ). Vital signs upon admission were similar for victims attacked by pit bulls and those attacked by other breeds (systolic blood pressure,  $P = 0.285$ ; heart rate,  $P = 0.208$ ; respiratory rate,  $P = 0.123$ ) (Table 4). The median Injury Severity Scale (ISS) score for

victims mauled by pit bulls (ISS, 4) was significantly higher than that for victims attacked by other breeds (ISS, 1;  $P = 0.002$ ); however, the Abbreviated Injury Scale category did not vary significantly according to breed, nor did the Trauma and Injury Severity Scores ( $P = 0.412$ ). The percentage of victims with an admission Glasgow Coma Scale (GCS) score of 8 or lower was significantly higher for victims attacked by pit bulls (17.2%) than for victims of attacked by other breeds (0%;  $P = 0.006$ ). Approximately one-third of all victims underwent surgical procedures for wound repair; this proportion was similar across breed categories (data not shown). During the first 30 days after the attack, the number of hospital-free days was significantly lower for victims attacked by pit bulls (median, 28 days; range, 0–29 days) than for victims attacked by other breeds (median, 28 days; range, 21–29 days;  $P = 0.009$ ). During the same period, the number of intensive care unit (ICU)-free days was significantly lower for victims attacked by pit bulls (median, 30 days; range, 0–30 days) than for those attacked by other breeds (median, 30 days; range, 23–30 days;  $P = 0.027$ ). Median hospital charges (victims attacked by pit bulls, \$10,500 [range, \$2500–\$42,700]; victims attacked by other breeds, \$7200 [range, \$1000–\$32,400])  $P = 0.003$ ; and the risk of death (victims attacked by pit bulls, 10.3%; victims attacked by other breeds: 0%;  $P = 0.041$ ) were significantly higher for victims of pit bull attacks.

Our review of records found 3 cases in which fatalities resulted from dog attacks. One of these cases was detailed above; a description of the other 2 cases follows.

A 10-year-old girl was attacked by a neighbor's pit bull, which was usually chained in the neighbor's yard. Tracheal intubation was performed at the scene, and cardiopulmonary resuscitation was in progress when the child arrived at the hospital. No vital signs or signs of life were detectable. Postmortem examination showed a deep laceration to the anterior left base of neck; this wound was believed to be the cause of death.

The third case was that of a 90-year-old man attacked by his own 2 pit bulls just after midnight. He was alone when injured and was found by emergency medical services personnel lying on the living room floor of his home, moaning but unresponsive. When the patient arrived at the hospital, tracheal intubation was performed, and he was taken to the operating room for debridement of wounds, which included multiple deep lacerations to his upper extremities, puncture wounds to his torso and lower extremities, and testicle avulsion. The patient spent 5 days in the ICU because of cardiac complications and ultimately died.

### Characteristics of the Attack and the Dog

We evaluated the relationship between the victim and dog (Table 5); this information was available for 58 of the 228 attacks. Dogs were classified as belonging to an acquaintance (5.2%), the victim's family (44.8%), a neighbor (20.7%), a relative (17.2%), or someone unknown to the victim (12.1%). There was no association between the breed of the attacking dog and the victim's relationship to the dog ( $P = 0.868$ ), the location of the attack ( $P = 0.725$ ), the type of restraint, if any, used on the dog ( $P = 0.133$ ), the type of provocation, if any ( $P = 0.182$ ), the sex of the dog ( $P = 0.565$ ), or the rabies vaccination status of the dog ( $P = 0.201$ ). The mean ( $\pm$ SD) number of dogs involved in the attack was higher when pit bulls were involved ( $1.3 \pm 0.7$  dogs) than when other breeds were involved ( $1.0 \pm 0.2$  dogs), but the difference was not statistically significant ( $P = 0.075$ ).

### DISCUSSION

The main findings of this study are that, in comparison to victims attacked by other breeds of dogs, victims attacked by pit bulls have a higher ISS score, a higher risk of an admission GCS score

**TABLE 3. Characteristics of Pit Bulls**

#### Fatal Pit Bull Attacks Nationally

Pit bulls attack indiscriminately
Responsible for 65% of all fatal attacks in 2008
6 of 7 fatal dog bites in Texas in 2007 were inflicted by pit bulls
94% of attacks on children by pit bulls were unprovoked
81% of attacks that occurred off the owner's property involved pit bulls
One person is killed by a pit bull every 14 days
One body part is severed and lost every 5.4 days as a result of pit bull attacks
2 persons are injured by pit bulls every day
1.5 pit bulls are shot to death every day

Adapted from references (Sacks, Kresnow et al. 1996;<sup>7</sup> CDC 2001;<sup>5</sup> CDC 2003; www.dogsbite.org<http://www.dogsbite.org>. Dogsbite.org anuary 3, 2009.; www.dogsbite.org<http://www.dogsbite.org>.<http://www.youtube.com/watch?v=X8nVTctxUDE> October 25, 2008).

The term *pit bull* refers to dogs from the following breeds: American Pit Bull Terrier, American Staffordshire Terrier, and Staffordshire Bull Terrier.

of 8 or lower, fewer hospital-free and ICU-free days, higher hospital charges, and a higher risk of death.

### Characteristics of the Pit Bull Breed

The pit bull is unique in many ways. Historically, the breed was derived from the "butcher's dog" developed for the blood sport of bull-baiting in England. The dogs were intentionally bred to be stronger than other dogs and to engage in dangerous behaviors that would favor their winning in the ring by fighting a bull to the death. When this sport was banned in England in approximately 1835, the owners took their dogs to the coal mining communities of Staffordshire County. There, the dogs were placed into coal pits to fight one another, and the breed was manipulated to be quicker and more agile. This breeding eventually resulted in the smaller, tenacious terriers now known as the American Pit Bull Terrier, the American Staffordshire Terrier, and the Staffordshire Bull Terrier. The name "pit bull" is associated with dogs displaying these phenotypes.<sup>13,14</sup> These fighting dogs were bred and trained *not* to display behavioral signals of their intentions so that they would have an advantage in the ring. For this reason, pit bulls are frequently known to attack "without warning."<sup>10</sup> For example, 1 study found that 94% of attacks on children by pit bulls but only 43% of attacks on children by other breeds of dogs were unprovoked.<sup>15</sup> Mythically, these dogs have been ascribed with supernormal strength and bite force and with "locking jaws," which are claimed to be responsible for the devastating injuries that the dogs can produce. Although it is clear that this breed of dog is muscular, strong, and tenacious, there is no evidence for the extreme bite force often reported in the applicable literature. The results of osteological studies of skull and jaw morphology suggest that, as the mass of the dog increases, small differences in mechanics due to skull morphology may produce a theoretical bite force advantage.<sup>16</sup> Dr. Brady Barr of the National Geographic Society tested the bite strength of live animals. The bite force of the Rottweiler was 328 psi, that of the German Shepherd Dog was 238 psi, and that of the pit bull was 235 psi. In comparison, the bite force of a gray wolf is more than 400 psi whereas that of a lion is 600 psi.<sup>17</sup> Therefore, it is not the biting force of pit bulls that is responsible for the damage they inflict. With regard to the locking-jaw theory, although pit bulls are bred to not let go, there is no such thing as a locking jaw mechanism in pit bulls or in any other canine.<sup>13</sup>

The attack pattern of pit bulls is different from that of other dogs. With other dogs, children are usually at highest risk of being

**TABLE 4.** Characteristics of 228 Dog Bite Victims Treated at a Level I Trauma Center Between January 1, 1994, and April 30, 2009

Characteristic	Breed of Attacking Dog			All Dogs, n	P Value <sup>†</sup>
	Pit Bull*, n	Other Breeds, n	Total, Breed Known, n		
Dog attacks, n	29	53	82	228	
Patient age, n (%)					0.096 <sup>‡</sup>
≤6 years	8 (27.6)	22 (41.5)	30 (36.6)	82 (36.0)	
6–11 years	6 (20.7)	13 (24.5)	19 (23.2)	42 (18.4)	
12–17 years	0 (0)	4 (7.5)	4 (4.9)	9 (3.9)	
≥18 years	15 (51.7)	14 (26.4)	29 (35.4)	95 (41.7)	
Dog attacks, n	29	53	82	228	
Patient sex, n (%)					0.176 <sup>§</sup>
Male	13 (44.8)	32 (60.4)	45 (54.9)	131 (57.5)	
Dog attacks, n	29	49	78	201	
Systolic BP, mean (SD)	117.1 (35.9)	124.3 (23.2)	121.6 (28.6)	125.5 (25)	0.285 <sup>¶</sup>
Dog attacks, n	29	50	79	207	
Heart rate, mean (SD)	102.4 (42.3)	112.4 (27.5)	108.8 (33.8)	105 (31)	0.208 <sup>¶</sup>
Dog attacks, n	29	49	78	201	
Respiration rate, mean (SD)	19 (7.7)	21.2 (4.7)	20.4 (6)	20.4 (5.4)	0.123 <sup>¶</sup>
Dog attacks, n	29	53	82	228	
ISS					
Median (IQR)	4 (4)	1 (0)	1 (3)	1 (3)	0.002 <sup>**</sup>
Minimum, maximum	1, 24	0, 25	0, 25	0, 30	
AIS-Head and Neck ≥ 3, n (%)	2 (7.6)	2 (3.8)	4 (5.1)	11 (5.1)	0.77 <sup>§</sup>
AIS-Face ≥ 3, n (%)	0 (0)	2 (3.8)	2 (2.5)	2 (0.9)	0.17 <sup>§</sup>
AIS-Chest ≥ 2, n (%)	1 (3.8)	0 (0)	1 (1.3)	3 (1.4)	0.27 <sup>§</sup>
AIS-Abdomen n (%) or AIS-Pelvis ≥ 3	1 (3.8)	0 (0)	1 (1.3)	3 (1.4)	0.44 <sup>§</sup>
AIS-Extremity ≥ 3, n (%)	1 (3.8)	0 (0)	1 (1.3)	8 (3.6)	0.25 <sup>§</sup>
AIS-External ≥ 2, n (%)	2 (7.7)	2 (3.8)	4 (5.1)	7 (3.2)	0.06 <sup>§</sup>
Dog attacks, n	29	53	82	228	
TRISS, Mean (SD)	0.92 (0.23)	0.86 (0.34)	0.88 (0.30)	0.81 (0.38)	0.412 <sup>¶</sup>
Dog attacks, n	29	49	78	208	
GCS Score ≤ 8, n (%)	5 (17.2)	0 (0)	5 (6.4)	10 (4.8)	0.006 <sup>‡</sup>
Dog attacks, n	28	53	81	227	
Hospital-free days Mean (SD)	22.5 (10.9)	28 (1.5)	26.1 (6.9)	26 (6.5)	0.009 <sup>**</sup>
Median	28	28	28	28	
Range	0, 29	21, 29	0, 29	0, 30	
Dog attacks, n	29	53	82	228	0.027 <sup>**</sup>
ICU-free days					
Mean (SD)	25.5 (10.3)	29.7 (1.2)	28.2 (6.5)	28.9 (4.7)	
Median	30	30	30	30	
Range	0, 30	23, 30	0, 30	0, 30	
Dog attacks, n	29	51	80	214	0.003 <sup>**</sup>
Hospital charges (K\$)					
Mean (SD)	32.2 (78.9)	8.0 (6.8)	16.8 (48.7)	14.9 (45.0)	
Median	10.5	7.2	8.1	6.5	
Range	2.5, 42.7	1.0, 32.4	1.0, 42.7	1.0, 45.2	
Dog attacks, n	29	53	82	228	
Mortality, n (%)	3 (10.3)	0 (0)	3 (3.7)	3 (1.3)	0.041 <sup>‡</sup>

Abbreviations: AIS, Abbreviated Injury Scale score; BP, blood pressure; GCS, Glasgow Coma Scale score; ICU, intensive care unit; IQR, interquartile range; ISS, Injury Severity Scale score; K\$, thousands of dollars; SD, standard deviation; TRISS, Trauma and Injury Severity Score.

\*The term *pit bull* refers to dogs from the following breeds: American Pit Bull Terrier, American Staffordshire Terrier, and Staffordshire Bull Terrier.

<sup>†</sup>Comparison of data in the columns labeled "Pit Bull" and "Other Breeds."

<sup>‡</sup>Statistical significance determined by Fisher exact test.

<sup>§</sup>Statistical significance determined by Pearson chi-square test.

<sup>¶</sup>Statistical significance determined by analysis of variance (ANOVA).

<sup>\*\*</sup>Statistical significance determined by Kruskal-Wallis test.

**TABLE 5.** Characteristics of the Attack and the Dog Involved

Characteristic	Breed of Attacking Dog			All Dogs, n	P Value <sup>†</sup>
	Pit Bull*, n	Other Breeds, n	Total, Breed Known, n		
Dog attacks, n	19	23	42	58	
Relationship of victim to dog, n (%)					0.868 <sup>‡</sup>
Acquaintance's dog	1 (5.3)	1 (4.3)	2 (4.8)	3 (5.2)	
Family dog	9 (47.4)	11 (47.8)	20 (47.6)	26 (44.8)	
Neighbor's dog	5 (26.3)	4 (17.4)	9 (21.4)	12 (20.7)	
Relative's dog	2 (10.5)	5 (21.7)	7 (16.7)	10 (17.2)	
Dog unknown to victim	2 (10.5)	2 (8.7)	4 (9.5)	7 (12.1)	
Dog attacks, n	15	18	33	42	
Attack Location, n (%)					0.725 <sup>‡</sup>
In house	3 (20)	6 (33.3)	9 (27.3)	12 (28.6)	
In yard	9 (60)	9 (50)	18 (54.5)	22 (52.4)	
Dog attacks, n	11	14	25	34	
Dog restraint, n (%)					0.133 <sup>§</sup>
Unrestrained	7 (63.6)	13 (92.9)	20 (80)	28 (82.4)	
Dog attacks, n	21	29	50	71	
Provocation, n (%)					0.182 <sup>‡</sup>
Running	0 (0)	1 (3.4)	1 (2)	1 (1.4)	
Feeding	0 (0)	1 (3.4)	1 (2)	1 (1.4)	
None	1 (4.8)	6 (20.7)	7 (14)	13 (18.3)	
Playing	2 (9.5)	4 (13.8)	6 (12)	8 (11.3)	
Petting	2 (9.5)	0 (0)	2 (4)	4 (5.6)	
Pulling	0 (0)	1 (3.4)	1 (2)	1 (1.4)	
Dog attacks, n	21	23	44	59	
Number of dogs involved in attack, mean (SD)	1.3 (0.7)	1 (0.2)	1.2 (0.5)	1.2 (0.5)	0.075 <sup>**</sup>
Dog attacks, n	7	26	33	33	
Sex of Dog, n (%)					0.565 <sup>‡</sup>
Male	5 (71.4)	20 (76.9)	25 (75.8)	25 (75.8)	
Dog attacks, n	4	7	11	19	
Rabies vaccination, n (%)					0.201 <sup>¶</sup>
Yes	2 (50)	6 (85.7)	8 (72.7)	15 (78.9)	

\*The term *pit bull* refers to dogs from the following breeds: American Pit Bull Terrier, American Staffordshire Terrier, and Staffordshire Bull Terrier.

<sup>†</sup> Comparison of data in the columns labeled "Pit Bull" and "Other Breeds."

<sup>‡</sup> Statistical significance determined by Fisher exact test.

<sup>§</sup> Statistical significance determined by analysis of variance (ANOVA).

<sup>¶</sup> Statistical significance determined by Pearson chi-square test.

<sup>\*\*</sup> Kruskal-Wallis Test.

bitten. In contrast, pit bulls seem to attack adults almost as frequently as they attack children.<sup>18</sup> Pit bulls not only are notorious for their indiscriminate attack pattern but also are well known for the tenacity with which they continue with an attack. The case fatality reported above involved an infant that was mauled by 2 pit bulls. These dogs had previously bitten an 8-year-old relative in the face. When the dog's owner attempted to stop the attack on the infant by stabbing the dogs with a knife, she became a victim herself, and police officers had to shoot (kill) the dogs at the scene.<sup>19</sup> It is not uncommon to hear of witnessed attacks in which the pit bulls could not be stopped from attacking.<sup>20,21</sup>

The inbred tenacity of pit bulls, the unrelenting manner in which they initiate and continue their attacks, and the damage they cause are the result of both genetics and environment. Therefore, this breed of dog is inherently dangerous.<sup>10,13,16,17,22</sup> As stated by 1 author, "Temperament is not the issue, nor is it even relevant. What is relevant is actuarial risk. If almost any other dog has a bad moment, someone may get bitten, but will not be maimed for life or killed, and

the actuarial risk is accordingly reasonable. If a Pit Bull Terrier or a Rottweiler has a bad moment, often someone is maimed or killed, and that has now created off-the-chart actuarial risk, for which the dogs and their victims are paying the price."<sup>18</sup>

Over a recent 3-year period from January 2006 to March 30, 2009, a total of 98 dog bite fatalities involving 179 dogs occurred; 60% of the deaths were caused by pit bulls, and 76% were caused by pit bulls and Rottweilers.<sup>11</sup> A total of 113 pit bulls were involved in these deaths, and they accounted for 63% of the dogs involved in fatal attacks (Table 2). If the risk of fatal attack is normalized to Labrador Retrievers and Labrador-mix breeds (the most common registered dog in the United States), the relative risk of death related to pit bull attacks is more than 2500 times higher. Data show that, in 2008, pit bulls alone were responsible for 81% of attacks that occurred off the owner's property; of these attacks, 85% involved more than 1 dog.<sup>11</sup> Although adults aged 21 to 54 years composed only 19% of all victims who died, 82% of these deaths were caused by pit bull attacks. Over a 3-year period, 54% of deaths due to pit

bull attacks occurred among adults (aged 21 years or older) and 46% occurred among children (aged 11 years or younger). In one 85-day period from July to September 2008, pit bulls were involved in 127 dog attacks, 57% of which occurred off the owner's property. In these attacks, 158 people were injured, 63% of them severely; 10% of the victims suffered severed body parts; and 6 victims were killed.<sup>12</sup> In the same period, 128 dangerous pit bulls had to be shot to death by police officers or citizens.<sup>12</sup> A closer look at these figures indicates that 1 person is killed by a pit bull every 14 days, a person loses a body part to a pit bull attack every 5.4 days, 2 persons are injured by pit bulls each day, and 1.5 pit bulls are shot to death each day (Table 3).

### Children as Frequent Targets of Dog Attacks

A 2008 national survey found that there is a general lack of knowledge regarding dog behavior and safety practices for dog-child interactions.<sup>22-24</sup> This finding partially explains the fact that children are 3 times as likely as adults to require medical attention for dog bites and the fact that injury rates seem to be highest among children aged 5 to 9 years.<sup>25-30</sup> Children are more likely to engage in behaviors that unknowingly provoke dogs.<sup>15</sup> Children are also more likely to be bitten in the head, neck, and face; thus, the number of children requiring medical attention is higher than the number of adults who require such care.<sup>5,27,31-37</sup> Children not only suffer physical scars but also sustain substantial and lasting psychological effects. Posttraumatic stress disorder is more common among children involved in violent attacks than among those experiencing only minor or incidental bites by a pet.<sup>38</sup>

### Costs of Dog Bites

Dog bites are the second most costly public health problem in the United States. In Kansas City, Missouri, between 1998 and 2002 the median cost per visit to an emergency department for a dog bite was \$300, and the median cost per admission to a hospital was \$4698.<sup>37</sup> A recent single-center review of 1347 nonfatal dog bites experienced by children reported that the direct cost of medical care during the 8-year study period was \$2.15 million; of this, \$1.4 million was covered by Medicaid and another \$122,000 was considered "self pay," which is often written off as charity care.<sup>36</sup> This amounted to a cost of \$1596 per incident, including the cost of care for the 91% of patients treated in the emergency department and released.<sup>36</sup> In Pennsylvania in 1995, the charges for hospitalizations that resulted from 469 dog bites totaled \$3.4 million; the median charge was \$4569 (mean charge, \$7288).<sup>39</sup> Notably, government payment sources were responsible for 48% of the total costs.<sup>39</sup> Insurance estimates from 2007 placed the annual cost of dog bites for home insurers in the United States at \$356.2 million; total losses may exceed \$1 billion per year.<sup>40</sup>

Dog bite ordinances vary widely across the United States. Seventeen states have "one bite" laws that do not hold the dog owner accountable for the actions of a dangerous dog until after the dog has caused harm, at which point it can be considered potentially dangerous or vicious. Twelve states have laws that specifically forbid municipalities to enact breed-specific laws or ordinances.<sup>41,42</sup> Currently, 250 cities in the United States have breed-specific ordinances, even though some of these cities are in states that prohibit breed-specific laws. Texas, the state that leads the nation in dog bite fatalities, is a "one bite" state that prohibits breed-specific laws.

In Texas, the laws regarding dogs that have been deemed dangerous are quite strict; these laws are similar to those regarding dangerous wild animals. The dangerous-dog law in Texas requires special registration and containment of the animal and imposes strict insurance liability requirements on owners. Similar requirements exist

with regard to the ownership of dangerous wild animals, such as lions, tigers, and bears. The difference between the approach to wild animals and the approach to dogs is that wild animals are defined as dangerous on the basis of their species, whereas dogs must cause bodily injury before they can be determined to be dangerous. Texas law specifically prohibits municipalities from enacting legislation specific to dog breeds; although municipalities can ban or restrict the ownership of species of wild animals within their jurisdiction, they cannot regulate the ownership of specific breeds of dogs.<sup>43,44</sup>

Our study showed that the dog bite injuries experienced by patients admitted to our level I trauma center over a 15-year period were severe, as manifested by the fact that nearly one-third of patients required operative intervention. Of particular interest was the fact that pit bulls, which were found to have attacked older persons, and inflicted much more devastating injuries than other breeds of dogs (as indicated by higher median ISSs and a higher percentage of victims with a GCS score  $\leq 8$ ), injuries that in some cases led to death. In addition, patients attacked by pit bulls experienced more morbidity (as indicated by higher ISSs and fewer hospital-free and ICU-free days) and incurred higher hospital charges than those attacked by other breeds. We should state that our study is limited by its retrospective nature and the limited number of cases in which the breed of dog responsible for the attack could be determined. This lack of information may compromise the validity of our results implicating the pit bull as a major culprit in severe dog bites admitted to our trauma center.

### CONCLUSIONS

Dog bites are a serious public health concern in the United States and across the world. They result in substantial emotional and physical trauma and in a substantial economic cost to the victims and to society. Fortunately, fatal dog attacks are rare, but there seems to be a distinct relationship between the severity and lethality of an attack and the breed of dog responsible. The unacceptable actuarial risk associated with certain breeds of dogs (specifically, pit bulls) must be addressed. These breeds should be regulated in the same way in which other dangerous species, such as leopards, are regulated. Individual municipalities need the power to enact ordinances that can protect their citizens from this risk. If they are to obtain such power, the issue must be addressed at the local, county, and state legislative levels.

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