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Dog and Cat Bites to the Hand: Treatment and Cost Assessment

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#### HEADNOTE

**Purpose:** To assess the demographic patterns, clinical morbidity, and treatment costs associated with domestic animal bites to the hand.

**Methods:** A retrospective review was performed on 111 patients who suffered either a dog or cat bite to the hand. Demographic data were collected for both the patient and the animal involved.

**Results:** The patient population had suffered 71 dog bites and 40 cat bites. Two scenarios were identified that increased the likelihood of a bite: (1) attempting to separate fighting animals and (2) attempting to aid an injured animal. More than half of the victims (61 of 111) were bitten by an animal with which they were familiar. Bite injuries ranged from relatively minor wounds to major injuries that included open fractures, persistent deep infection including osteomyelitis, nerve laceration, tendon laceration, or tissue loss. Approximately two thirds of patients required hospital admission at least for intravenous antibiotics. Approximately one third of animal bite victims required at least 1 surgical procedure. Thirteen patients required long-term intravenous antibiotics and/or multiple surgeries and incurred medical expenses in excess of \$77,000.

**Conclusions:** Domestic animal bites to the hand are common injuries that can produce considerable morbidity. Stray animals did not account for the majority of incidents. Bite prevention strategies should focus on careful handling of animals that are fighting or injured. Animal bite wounds often require intravenous antibiotics and hospitalization and the cost of care for deep infections can be enormous. Our patient population was selected from a small geographic area over a relatively short collection period, suggesting that domestic animal bite injuries may represent a major public health issue. (J Hand Surg 2006;31A:468-473. Copyright © 2006 by the American Society for Surgery of the Hand.)

**Type of study/level of evidence:** Prognostic, Level IV.

**Key words:** Bites, cat, cost assessment, dog, hand.

As the popularity of household pets continues to grow the incidence of domestic animal bites has increased to epidemic proportions, posing a major public health concern to the United States.<sup>1</sup> According to the American Pet Products Manufacturers Association 2005-2006 National Pet Owners Survey there were 73.9 million dogs and 90.5 million cats owned by people in the United States (<http://www.appma.org>). It is estimated that 2 million Americans are bitten by a domestic animal each year and that 50% of Americans will be bitten in their lifetimes.<sup>2</sup> Animal bites currently constitute 1% of all emergency room visits in this country.<sup>3</sup>

Dog bites account for approximately 80% to 90% of domestic animal bites and about 2% of these bites require hospitalization.<sup>4</sup> It is estimated that there are 4.7 million dog bites each year, although the actual number is unknown. The high incidence of dog bites reflects a canine population that has increased 4 times faster than the human population over the same time period. According to American Pet Products Manufacturers Association statistics currently approximately half of all households in the United States now own either a dog or a cat.

The animal is known to the victim in more than 80% of domestic bite incidents.<sup>5</sup> The estimated overall infection rate for dog bites, between 2% and 20%, is one of the lowest among mammals.<sup>6,7</sup> Bites to the hand and upper extremity comprise 18% to 68% of all dog bites and are associated with an increased risk for tenosynovitis, septic arthritis, and abscess formation.<sup>3</sup> Approximately 334,000 Americans visit emergency departments each year with dog bite-associated injuries and another 466,000 are seen in other medical settings.<sup>8</sup> The incidence of severe or fatal dog bites has increased as dog owners have acquired larger, more aggressive breeds for home protection. Jack Russell terriers, German shepherds, Chow Chows, and pit bull terriers are breeds that are more prone to attack without provocation.<sup>9,10</sup>

Cat bites represent the second most common domestic mammalian bite in the United States and account for 5% to 15% of all domestic animal bites. The estimated annual incidence of domestic cat bites in the United States is 400,000.<sup>11</sup> Of those with problematic bites who seek medical attention, about two-thirds have bites that affect the upper extremity.<sup>12</sup> The associated infection rate for domestic cat bites ranges from 30% to more than 50%, which is more than double the infection rate for dog bites.<sup>3,5-7</sup> It has been our observation that the sharp slender teeth of cats can penetrate joint capsule or bone easily, resulting in septic arthritis or osteomyelitis.

The purposes of this retrospective study were 3-fold: (1) to characterize the circumstances surrounding the domestic animal bite and thereby help determine prevention strategies for avoiding these injuries, (2) to examine the clinical morbidity secondary to these bites and classify patients according to specific patterns of treatment, and (3) to assess the treatment costs associated with dog and cat bites to the hand.

## Materials and Methods

The charts of 111 patients who had been treated for a domestic dog bite or cat bite by 1 of 3 hand surgeons from the same practice from 1997 to 2003 were reviewed retrospectively. There were 38 male and 73 female patients.

Each patient chart was reviewed for patient age at the time of the injury and the circumstances surrounding the event including breed of animal (if known), how the bite occurred, and whether the animal was known to the victim. The treatment course also was documented. This included an evaluation of the number of office visits required, the nature of emergency room care, whether hospital admission was necessary, what specific surgical interventions were necessary, whether intravenous (IV) antibiotic therapy was administered, and whether occupational therapy was prescribed. Five different treatment patterns emerged from the data and these 5 specific treatment pathways were used to categorize the patients.

The various costs of care were calculated from hospital charges for the goods and services that were involved in the care of the bite victim. This included the cost of emergency room evaluation, IV placement, antibiotic therapy, operating room time, hospital bed charges, anesthesia charges, medication costs, and percutaneous indwelling central catheter (PICC) line placement. We also tabulated surgeons' fees and the charges accrued by office visits with the hand surgeon and occupational therapist. Both the hospital pharmacy and a local pharmacy were used to obtain the cost for medications.

We attempted to identify any possible correlation between cost of care and bite location and number of bites. Specifically the location of wounds (finger, hand, wrist, forearm) and the number of wounded areas (single vs multiple) were recorded and tabulated with respect to the 5

treatment pathways.

## Results

Of the 111 charts reviewed 40 were from patients with cat bites and 71 were from patients with dog bites. Twenty dog bite victims were male and 51 were female. Thirteen of the cat bite victims were male and 27 were female. The age range of the dog bite victims was 9 to 100 years (mean, 50.0 y). The age range of the cat bite victims was 15 to 80 years (mean, 48.7 y).

Eleven of the patients reported the following breeds of dogs involved in the attack: German shepherd (n = 2), Rottweiler (n = 3), Chow Chow (n = 1), Bassett Hound (n = 1), pit bull terrier (n = 1), Labrador retriever (n = 1), St. Bernard (n = 1), and golden retriever (n = 1). Information about cat breeds was not reported. The 2 most common biting scenarios involved the victim attempting to separate fighting animals or attempting to provide first aid to an injured or sick animal. Much less common were bite episodes related to rough play, food possession, or grooming. Only 4 of the dog bites and 3 of the cat bites were reported to be from stray animals. Seventeen of the cat bites and 44 of the dog bites were received by the animal's owner or by a friend or relative of the owner. Nine of the cat bites and 8 of the dog bites occurred while the victim was working either as a veterinarian, veterinary technician, groomer, K-9 police dog handler, or animal shelter or pet shop employee.

The average time from injury to medical evaluation by a hand surgeon was 7.8 days. The bite locations for cat-related wounds were as follows: 20 finger wounds, 15 hand wounds, 6 wrist wounds, and 5 forearm wounds. The locations of the dog bites were as follows: 27 finger wounds, 42 hand wounds, 2 wrist wounds, and 10 forearm wounds. Eighty-one patients were treated in the emergency room and 65 patients required hospital admission. The number of days of hospital admission for a cat bite ranged from 2 to 8 (average, 4.3 d). The number of days of admission for a dog bite ranged from 2 to 11 (average, 4.3 d). Overall 34 patients required surgical treatment. Twenty-one patients required a simple surgical irrigation and debridement. Six patients (3 with cat bites, 3 with dog bites) required more extensive surgery including an irrigation and debridement and a tendon and/or nerve repair and/or bone debridement. Seven patients (4 with cat bites, 3 with dog bites) with osteomyelitis required bone debridement followed by PICC line placement with longterm IV antibiotic therapy. Twenty-three patients suffered permanent impairment such as loss of tissue (iingertip), loss of joint motion, or major motor and/or sensory impairment.

## IMAGE TABLE

1

Table 1. Severity of Injury Categories and Associated Cost of Care

The patients were grouped into 5 severity-of-injury categories based on the level of care necessary to treat their injuries (Table 1 ). Forty-seven patients were assigned to category 1, which involved the least amount of care with costs averaging \$1,880. Thirty patients were classified in category 2, which involved hospital admission for IV therapy, with an average cost of \$ 11,174. Twenty-one patients were in category 3; they required admission combined with a simple irrigation and debridement. increasing the average cost to \$17,906. Seven patients required admission, surgical debridement for osteomyelitis, and 6 weeks of IV antibiotic therapy, which increased the mean cost of these category 4 patients to \$77,730 per patient. Six patients in category 5 required a bony debridement and nerve and/or tendon repair with 6 weeks of IV therapy, which increased the average cost to \$81,926.

Table 2 summarizes the severity of injury, location of bite, and multiplicity of bites based on whether a dog or cat was the biting animal. Table 3 compares the location of bite wounds (finger, hand, wrist, forearm) and multiplicity of bite wounds with the severity-of-injury category. An analysis of variance was performed to determine if the location of the bite wound in any way

correlated with the severity of injury. The p value for this analysis was .60, suggesting that no such correlation existed.

## Discussion

Domestic animal bites represent a noteworthy public health issue in the United States. As dog and cat ownership increases this problem will continue to escalate. Animal bites are responsible for 0.5% to 0.65% of emergency room visits.<sup>13</sup> The incidence of domestic animal bites is difficult to determine because not all bites are reported. Assuming a 50% reporting rate it is estimated that there are 3.5 million to 4.7 million domestic animal bites every year in the United States.<sup>1,4,14</sup>

### IMAGE TABLE

2

Table 2. Severity, Location, and Multiplicity of Bite Wounds Organized by Biting Animal

### IMAGE TABLE

3

Table 3. Location and Multiplicity of Bite Wounds Organized by Severity

Analysis of these data reflect a higher occurrence of dog bites over cat bites in our patient group. This finding is consistent with other reports that have shown a dog bite incidence of 80% to 90% of all animal bites compared with the known incidence of cat bites (5% to 15%).<sup>6</sup> When comparing the numbers overall, however, there is a higher proportion of cat bites being referred for more invasive treatment. With an infection rate of 30% to 50%<sup>6</sup>-more than double that of dog bites-this is to be expected.

The age of the domestic animal bite victims in our study population is somewhat higher than the national average. Nonfatal dog bites have been shown in the past to be highest among children ages 5 through 9 years.<sup>4</sup> Forty-two percent of dog bite victims in a previous study were younger than 18 years and more than half of all victims were male.<sup>14</sup> Some studies have suggested that women are afflicted with cat bites more frequently owing to a greater number of female cat owners.<sup>5</sup> The data from the current study show a prevalence of both dog and cat bites for women.

Many patients did not report a specific breed of dog in association with their bite and therefore it was not possible to make any particular breed-specific risk assessment. For those patients who did report a particular dog breed no specific pattern emerged. It is our opinion from this study that any dog is capable of inflicting a serious bite given the right circumstances. Outcome was not associated with the location of the bite. In particular bites to the fingers, hand, or wrist need to be judged individually because injury in any of these areas has the potential to become infected and produce notable morbidity. Similarly multiple bite wounds did not correlate necessarily with a worse prognosis. Although patients often imagine that serious bite wounds are caused only by large and aggressive guard dogs inflicting multiple dramatic lacerations, the opposite more often is true. It is the single bite puncture from a small and normally nonaggressive dog or cat that often is underestimated, is not treated promptly, ultimately requires surgical management for deep infection, and results in some permanent residual impairment.

Prior studies have shown that more than 50% of dog bites to children are from animals known to the family.<sup>4,5,10,13,14</sup> The data from the current study confirm this finding in adults as well, with 44 of 71 dog bites and 17 of 40 cat bites coming from a pet well known to the victim.

In 2001, 4.5% of injuries caused by dog bites were reported to be work related.<sup>4</sup> The current data

suggest that work-related animal bite injuries might be higher given that 11.3% of the dog bites and 15.3% of all bites reported in this study occurred on the job.

It should be noted that this study has several inherent limitations. First, the data are based on incidents that were referred to 3 hand surgeons and do not necessarily reflect all animal bites that occurred in our community during the study time period. Furthermore this pattern of referral biases the data toward more serious bite injuries. Also we were not able to determine the breed of all dogs or cats in the study, therefore making it impossible to determine the risk of the bite by breed.

Despite these limitations, this study does bring several key issues into focus. >From a medical management perspective dog and cat bite wounds can be labor-intensive problems that require surgical debridement and prolonged hospitalization. Delay in presentation is a critical factor that prolongs recovery and necessitates more invasive treatment. Our experience in managing these challenging wounds also has been supported by other investigators.<sup>15-17</sup>

Although this study was not designed originally to predict the prognosis of animal bites based on bite pattern, some information about this topic is available from our data. First, it seems that the location of the bite itself, whether on the finger, hand, wrist, or forearm, is not a good predictor of injury severity. There was no statistical correlation between cost of care and specific bite location in our patients. Next, it would appear that both dog and cat bites have the potential to cause osteomyelitis and permanent impairment; patients in categories 4 and 5 had an almost equal number of cat and dog encounters. Last, the presence of multiple wounds from the same bite incident does not seem to correlate directly with injury severity. Only 19 of our patients suffered multiple bite wounds and only 8 of the multiple bite patients were in severity category 4 or 5. We believe that these data support the conclusion that every patient with an animal bite must be judged individually. The type of animal (dog or cat), the location of the wound on the upper extremity, and the presence of a single- or multiple-bite wound pattern should not be used by themselves to justify a specific treatment program. As an example, 1 of our patients who required surgical debridement, 6 weeks of IV antibiotics via a PICC line, and multiple hospitalizations related to antibiotic complications presented initially (after 4 weeks of delay) with a single cat bite wound to the tip of the index finger.

Certain bite patterns deserve special mention. Cat bites in general tend to be small puncture wounds that seal off almost immediately. The key to management is opening up every puncture site so that the wound can be cleaned and allowed to drain. Even when opened initially, cat bite punctures tend to reseal quickly and will quickly organize into an abscess if not kept open. Dog bite wounds are different because canine teeth are set into a muzzle designed for ripping and tearing food. Therefore these wounds typically are longitudinal lacerations that are more likely to stay open by themselves; however, canine-induced lacerations, as opposed to cat bite punctures, are more likely to result in direct structural damage to nerves, tendons, vessels, and joint structures. Again, allowing open drainage is essential and the temptation to suture dog bite wounds closed must be resisted. Bite wounds that produce exposed joints or tendons can be problematic particularly because leaving the wound open can at the same time result in desiccation of critical structures such as tendon or cartilage. Multiple bites in the same digit are common because the animal's upper and lower jaw commonly inflict damage to both sides of the victim's hand or finger. Furthermore multiple bite wounds in the same area inflict a greater load of bacteria and soft-tissue injury per unit area and this pattern of injury often results in aggressive infection, compared with a single bite wound on the dorsum of the hand. Bite wounds that can produce particularly damaging patterns of infection are those that contaminate closed spaces in the hand such as the digital pulp space, the nail bed area, the flexor tendon sheath, any of the deep spaces of the palm or thenar regions, and any of the joint spaces of the fingers or wrist. Infections that involve these areas often result in the need for surgical debridement, possibly several times, and a protracted course of IV antibiotics.

Bite injuries to the hand by dogs or cats are common and often are underestimated. Although the patient often initially attempts self-treatment, the reality is that almost two thirds of bite victims will

need to be admitted to a hospital. Approximately one third of bite victims who present to the emergency room will require surgical care. The total cost of care for our 111 patients was estimated to be more than 1.8 million dollars. This represents bite wounds treated by only 3 hand surgeons covering a small geographic area during an approximately 5-year period. Data from 1994 suggest that about 327,000 patients required emergency room treatment and another 6,000 patients required hospital admission.<sup>4</sup> This number of hospital admissions seems low compared with our data and we would speculate that the cause of admission may be reported frequently as simply infection, thereby resulting in an underreporting of admissions as a result of animal bites. By using our cost data to estimate both expenses and severity distribution it can be projected conservatively that the cost of care for dog and cat bites just to the upper extremity in the United States is more than 850 million dollars per year. Furthermore this figure is based on the cost of direct medical care for our patient population and does not take into account the economic and personal losses associated with time off from work or permanent impairment of the hand.

Delay in presentation has particular implications with respect to the cost of care. Early intervention is the best way to reduce the likelihood of infection spreading to deeper structures. It is particularly noteworthy that just 13 patients (categories 4 and 5 combined) accounted for 56% of the total cost of care for all 111 patients. Early treatment with antibiotics and wound care may help avoid the enormous expense associated with bone and joint infection. This early intervention of course depends on the patient seeking care promptly after the bite occurs.

Our study also emphasizes certain predictable behavior patterns by both human beings and animals involved in the bite incident. Rescuing injured animals or separating animals that are fighting are scenarios that commonly result in a serious bite. In addition, it is the person who is most familiar with the pet who often is bitten. Dog-training professionals have recommended that if a pet is engaged in an altercation with another animal then the safest way to separate the animals is to grab the hind legs of 1 animal and pull it away; intervening at the mouth end of the dog or cat is certain to result in injury (Alex Brooks School of Dog Training, [www.absdt.com](http://www.absdt.com), Des Plaines, IL, personal communication, August 2005). Stray animals do not account for a notable percentage of bite injuries. Bite victims tend to underestimate the care required for managing their injury and as a result they often delay for up to a week before presenting for care, a factor that often makes the treatment pathway more complicated. This delay in presentation may be related to the patient's embarrassment about suffering an injury from a pet and the owner's motivation to protect a pet from scrutiny related to biting behavior. Educating the public about the predictable biting scenarios of their pets, the need to care for bite wounds immediately, and the potentially complicated treatment needed for animal bites may help reduce the frequency and enormous expense associated with these injuries.

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