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Factors affecting length and complexity of hospital stay in pediatric dog bite patients

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ABSTRACT

Background Dog bite injuries are a source of significant morbidity and expense in the USA, and rates of hospitalization have been rising. Children are at increased risk of dog bites compared with adults, yet there is a lack of published material on factors affecting hospital course. The objective of this study is to explore factors associated with increased length of stay (LOS), more complex course of care and post-discharge return rates in this population.

Methods A retrospective review was conducted of all patients presenting to our urban, academic children's hospital for dog bite injuries between January 2016 and May 2021. Only those patients admitted for inpatient care were included, as identified through our institution's trauma registry, and variables were examined prior to, during, and after hospital stay.

Results 739 pediatric patients in total were treated for dog bites during the study period, of which 349 were admitted. Analysis revealed two pre-admission predictors of increased LOS: bone fracture (mean LOS=5.3 days vs. 2.5 days, p=0.013) and prior medical comorbidity (4.3 days vs. 2.8 days, p=0.042). After admission, fractures were associated with a higher rate of postoperative complications (16% vs. 5.6%, p=0.014) and return (13% vs. 2.0%, p<0.001), primarily due to wound infection. Although the facial region represented the largest proportion of fractures, long bone fractures of the arm and leg were noted to have comparatively higher LOS and complication rates. Postoperative complications were not associated with any documented infection at admission.

Conclusions Our findings suggest that long bone fractures in pediatric dog bites can be an underappreciated source of latent wound infection associated with late-presenting negative outcomes. Increased awareness of these relationships could lead to earlier detection of infection in this vulnerable population.

Level of evidence Level III, Prognostic / Epidemiological.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Hospitalization rates for dog bite injuries are rising, and children are more likely to be bitten than adults; however, there is a lack of published material on factors affecting hospital course in pediatric dog bite patients.

WHAT THIS STUDY ADDS

⇒ Pediatric dog bite patients who presented with fractures, in particular long bones of the arm and leg, experienced significantly longer and more complex hospital courses, increased complication rates, and were more likely to return after discharge despite no association with documented infection at the time of admission.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Thorough initial triage for dog bite-associated fractures and high clinical suspicion for wound infection in this patient subgroup could lead to earlier detection and treatment toward improved outcomes.

INTRODUCTION

Dog bite injuries are a source of significant morbidity and expense in the USA and throughout the world. Over 4.5 million people in the USA are bitten by dogs each year, up to 20% of whom require formal medical attention.[1–3] It has been well documented that children are more likely to be bitten than adults, and interestingly, this number has been rising with one national study showing that the rate of emergency department (ED) presentations for dog bites among patients younger than 18 years increased from 17.7 to 22.3 per 10 000 encounters between 2002 and 2017, whereas those above age 18 years did not change significantly during the same time period.[1 4 5] Rates of ED visits for bite injury are highest between 5 and 11 years of age, followed closely by children below age 5 years.[2 5–9] This rate falls dramatically above the age of 18 years.[2 5 8]

Among ED encounters for dog bites in the USA, studies show that only 2% to 10% are admitted for inpatient hospital care.[2 4 6–11] Nevertheless, both the raw number and rate of hospitalization are rising, with an analysis by the Agency for Healthcare Research and Quality (AHRQ) showing a 55% increase in the rate of dog bite-related hospitalization between 1993 and 2008 along with higher than average costs.[2] When calculated in 2008 by the AHRQ, the average cost of hospitalization for a dog bite was approximately 50% higher than the average inpatient stay across all injury diagnoses. In addition, dog bite patients required shorter hospital stays than the overall average, resulting in a notably higher cost per day for dog bite-related stays compared with the average injury.[2] Although this report does not include a breakdown of cost by age, the percentage of hospitalized patients younger than age 18 years was 21.5% within the dog bite group in contrast to only 6.7% across all injuries.

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Similarly, the average age of a hospitalized dog bite patient was 16 years below the average across all injury diagnoses (41 years vs. 57 years), in keeping with the epidemiological trend established above that pediatric patients are disproportionately represented among dog bite victims.[2]

Considering the major impact of this injury type on the pediatric population as well as the high cost per day of dog bite-related inpatient stays, there is a surprising lack of published material describing factors that extend or otherwise affect hospital course in children admitted for a dog bite. Anticipated length of stay (LOS) in this group varies widely depending on institutional norms and treatment strategies, as is represented in the literature with individual stays ranging anywhere from 0 to 118 days and study means ranging from 2.5 to 6.6 days.[1 2 6 9 12] However, few publications investigate which characteristics contribute to this variety in findings. The following study aims to address this gap by reporting one institution's experience of factors associated with increased LOS, postoperative complication, and rates of post-discharge return for either readmission or an additional procedure in this growing patient population. In particular, we hypothesized from our practice that bite-related fracture at presentation would be prominently associated with increased LOS and complication rates.

METHODS

A retrospective chart review was conducted of all patients presenting to our urban, academic children's hospital for dog bite injury between January 2016 and May 2021. Patients were identified from our trauma registry after institutional procedure to filter for type and mechanism of injury. All patients discharged directly from the ED or held overnight only for observation were excluded from full analysis, and only those patients admitted for inpatient care were included for a thorough, full-text review. One inpatient mortality was also excluded. Variables collected included standard patient demographics, site and nature of the bite, patient medical and social comorbidities, any prior care received, medical specialties involved, procedure details, length of hospital stay, postoperative complications and future interventions, including both planned procedures and unplanned readmissions or procedures related to the same injury. All data were manually extracted from patient charts and entered into Microsoft Excel software. Analysis was conducted with IBM SPSS Statistics V.22.0 using univariate Pearson's and Fisher's exact tests as well as a parametric independent sample t-test. Significance was set at a standard p value of 0.05 for all factors. This project follows the Strengthening the Reporting of Observational Studies in Epidemiology guidelines for observational studies to ensure the quality and strength of reporting (complete checklist uploaded as online supplemental content 1).

RESULTS

A total of 739 pediatric patients were evaluated and treated at our institution for dog bite injuries during the study period, of which 349 (47%) were admitted for inpatient care and included in the present results. Overall demographic and pre-admission injury characteristics are provided in table 1. Forty-two percent of our study group fell below the age of 5 years, 45% between the ages of 5 and 11 years, and the remaining 13% above age 11 years. For the purposes of this study, medical comorbidity included infection of the wound documented at initial presentation (representing the majority of this group) as well as medical disorders of wound healing. Social comorbidity included multiple dogs in the home, history of dog bite, documented learning, behavioral or communication disorder, or history of abuse within the home. Prior care describes any visit to a medical facility, whether urgent care, clinic, or other hospital, to receive care for the present injury before presentation to our ED. Analysis of factors prior to presentation revealed two primary predictors of increased LOS. First, patients who presented with any bone fracture had a mean LOS of 5.3 days in contrast to a mean of 2.5 days for those without a fracture (p=0.013). Second, patients presenting with a prior medical comorbidity stayed a mean of 4.3 days versus a mean of 2.8 days without (p=0.042). Table 2 includes a breakdown of all bone fractures by anatomic location with LOS and associated complications.

Details of inpatient stay for the full study group are included in table 3, with some additional findings highlighted here. Among the 31 patients (8.9%) who were transferred between primary services during their care, the most frequent receiving team was infectious disease (n=14). Analysis of factors during inpatient care revealed that LOS was significantly higher for patients in three categories. Those who underwent multiple procedures during the same admission had a mean LOS of 10.9 days versus 2.3 days for those without (p=0.001), whereas patients who

Table 1 Demographics and pre-admission injury characteristics among all pediatric dog bite patients admitted for inpatient care within the study period (n=349)

Category	N (%)
Age (years)	
Mean	6.3
Range	0–17
Sex	
Male	197 (56)
Female	152 (44)
Bite location*	
Face	244 (70)
Periorbital	84 (24)
Arm and leg	64 (18)
Nose	50 (14)
Hand and foot	43 (12)
Ear	30 (8.6)
Head	29 (8.3)
Trunk	14 (4.0)
Neck	12 (3.4)
Genitalia	2 (0.6)
Multiple locations	
Above neck only	98 (28)
Below neck only	13 (3.7)
Both above and below	40 (11)
Total	151 (43)
Fracture†	45 (13)
Patient history	
Medical comorbidity	24 (6.9)
Social comorbidity	87 (25)
History of traumatic injury	63 (18)
Prior care	
Seen by an outside facility	207 (59)
Received antibiotics	90 (26)
Received dressing	35 (10)

*Describes the frequency of individual injury sites including patients with multiple bite locations; as such, percentages do not add to 100%.
†See table 2 for a breakdown of fracture location and associated complications.

Table 2 Breakdown of all patients with a fracture (n=45) by location, including mean LOS and complications

Location of fracture	Number of patients	Mean LOS (days)	Number of patients with a postoperative complication
Head and face	23	4.8	2 (8.6%)
Hand and foot	12	2.4	2 (16%)
Arm and leg	8	11.3	3 (38%)
Clavicle	1	3.0	0 (0.0%)
Spine	1	4.0	0 (0.0%)
Total	45	5.3	7

LOS, length of stay.

were transferred between services stayed a mean of 7.2 days versus 2.4 days for those without a transfer (p=0.005). Finally, as might be expected, patients who experienced postoperative complications stayed significantly longer for a mean LOS of 8.7 days compared with 2.4 days for those with an unremarkable postoperative course (p=0.003). The most frequent complication was wound infection (16 of 24), whether demonstrated by microbiologic cultures or diagnosed clinically through findings such as fever, erythema, and purulent discharge. A breakdown of all postoperative complications is provided in table 4. Of note, patients who presented with a fracture were significantly more likely to undergo multiple procedures (18% of those with a fracture vs. 4.6% without a fracture, p=0.001), be transferred between services (24% vs. 6.6%, p<0.001) and experience postoperative complications (16% vs. 5.6%, p=0.014). Among the eight total patients who required stays in the pediatric intensive care unit, four (50%) had a fracture.

Finally, patients who had presented with a fracture were significantly more likely to return for future interventions, both unplanned (13% of those with a fracture vs. 2.0% without a fracture, p<0.001) and planned (22% vs. 6.3%, p<0.001). All statistically significant comparisons of the fracture cohort are summarized in table 5. For the purposes of this study, an unplanned future intervention was defined as an unscheduled return to the same medical center after discharge, requiring either a procedure to be performed or admission for inpatient medical management. The 29 patients (8.3%) which required planned, scheduled future interventions typically did not involve admission.

DISCUSSION

Dog bites are most prevalent among younger ages, even within the pediatric population, and the age distribution of our admitted patients runs parallel with this nationwide trend. Similarly, the high proportion of bites to the face and head among our study population is unsurprising; previous studies have reported 56% to 80% of pediatric dog bite injuries occurring in this region, with younger children disproportionately represented at the upper end of this range.[1 3 6–8 13–15] This higher incidence of dog bites among younger patients accompanied by more frequent facial wounds has been attributed to shorter stature, undeveloped motor skills, immature risk assessment, and inability to recognize signs of danger.[1 7 10] In addition, small children may be more likely to activate hunting instincts in large-breed dogs. These characteristics make younger children more of a target and less able to escape or mitigate harmful interactions with animals, whereas the face and head become more vulnerable to attack. Of note, neither patient age nor the location of the bite was statistically associated with increased LOS, complication or return rates in our study.

Although the distribution of age and bite location was comparable, our admission rate of 47% is dramatically higher than what has been described in the literature, which is typically <10% as cited in the introduction. In addition, the percentage of our patients presenting with fracture injuries (13%) was higher than

Table 3 Details of inpatient care among all pediatric dog bite patients admitted within the study period (n=349)

Category	N (%)
Length of stay (days)	
Mean	2.9
Range	1–34
Median	2.0
Primary service	
Admitting service	
Plastic surgery	137 (39)
Infectious disease	120 (34)
Trauma surgery	59 (17)
Ophthalmology	9 (2.6)
Orthopedics	9 (2.6)
Pediatrics	9 (2.6)
Neurosurgery	2 (0.6)
Intensive care unit	2 (0.6)
Urology	1 (0.3)
Otorhinolaryngology	1 (0.3)
Discharge service	
Plastic surgery	142 (41)
Infectious disease	133 (38)
Trauma surgery	41 (12)
Orthopedics	10 (2.9)
Pediatrics	10 (2.9)
Ophthalmology	8 (2.3)
Neurosurgery	2 (0.6)
Urology	2 (0.6)
Otorhinolaryngology	1 (0.3)
Transferred services	31 (8.9)
Operating service	
Plastic surgery	240 (69)
Multiple services	23 (6.6)
Trauma surgery	20 (5.7)
Ophthalmology	18 (5.2)
Orthopedics	11 (3.2)
Emergency medicine	6 (1.7)
Otorhinolaryngology	2 (0.6)
Urology	2 (0.6)
Neurosurgery	1 (0.3)
No procedure done	26 (7.4)
Procedure	
Location	
Operating room	209 (60)
Bedside	114 (33)
No procedure done	26 (7.4)
Multiple procedures	22 (6.3)
Postoperative complications*	24 (6.9)
Intervention after discharge	
Unplanned	12 (3.4)
Planned	29 (8.3)
Multiple	8 (2.3)

*See table 4 for a breakdown of all postoperative complications.

Table 4 Breakdown of all patients with a postoperative complication (n=24) by type, including location and mean LOS

Type of complication	Number of patients	Location of bite (n)	Mean LOS (days)
Infection	16	Face (11), extremity (5)	6.8
Soft tissue	12	Face (11), extremity (1)	5.3
Osteomyelitis	4	Extremity (4)	11.0
Graft ischemia	6	Face (5), extremity (1)	13.5
Encephalopathy	1	Extremity (1)	14.0
Hypersensitivity	1	Face (1)	6.0
Total	24	Face (17), extremity (7)	8.7

LOS, length of stay.

other studies, which report fracture rates of 6.9% to 8.9% in the pediatric population.[1 9 11 12] This can be largely attributed to our institution's status as a regional referral center, resulting in an influx of high-severity injuries transferred from local hospitals. Accordingly, of the 45 patients with a fracture, the majority (76%) had been first evaluated at an outside facility prior to arrival at our institution and just over half (51%) received antibiotics either prior to or during interfacility transfer. This calls for further investigation considering that, as shown previously, any fracture at presentation was the strongest predictor of longer and more complex hospital courses as well as readmission rates in our study.

Although fracture has been commonly used when defining the severity of dog bites and as a predictor of the need for hospitalization, at the time of this writing, there is no published examination of fracture in general as it relates to inpatient hospital courses for pediatric patients.[3 10 11] Previous interest has almost exclusively centered on craniofacial fractures, with the only dedicated discussion of non-facial fractures secondary to dog bite limited to case studies published >25 years ago.[13 16–21] This focus on facial fractures is understandable considering the consistently high proportion of injuries in the facial region and the delicate nature of facial bony structures. However, although the face and head region did represent the most frequent location for fractures in our study at 51%, we found that patients with long bone fractures of the arm and leg had disproportionately longer hospital stays regardless of postoperative complication. Patients with fractures of the arm and leg (specifically humerus, radius, ulna, femur, tibia, or fibula bones) stayed for a mean of 11.3 days; in contrast, those with facial and head fractures stayed for a mean of 4.8 days as seen earlier. In addition, of the seven patients with a fracture who experienced postoperative complications, three had long bone fractures, whereas only two had facial fractures. This represents a complication rate of 38% (3 of 8) for long bone fractures as opposed to 8.7% (2 of 23) for the facial group, indicating that long bone fractures of the arm and leg may deserve more consideration than they currently receive.

Table 5 Comparison of statistically significant differences between the cohort of patients who presented with a fracture and those who did not

	With fracture	Without fracture	P value
Mean LOS (days)	5.3	2.5	0.013
% of patients who experienced:			
Multiple procedures	18	4.6	0.001
Transfer between services	24	6.6	<0.001
Postoperative complications	16	5.6	0.014
Unplanned future intervention	13	2.0	<0.001
Planned future intervention	22	6.3	<0.001

LOS, length of stay.

The second pre-admission factor associated with increased LOS which necessitates further investigation is prior medical comorbidity, specifically prior wound infection. Interestingly, although it was associated with longer hospital stays, there was no relationship between documented wound infection at admission and postoperative complication of any type, including either soft tissue infection or osteomyelitis. In other words, the majority of patients who developed an infection at some point during their stay did not have any signs of infection when they presented initially. Narrowing this down to the fracture group specifically, only one of seven (14%) patients who experienced a postoperative complication presented with a medical comorbidity at admission. Further examination of these patients with fracture who experienced complications shows that all seven had received care at an outside facility, but only two of seven (29%) received antibiotics before arrival at our institution. This is notable considering that patients who presented with a fracture were nearly three times more likely to experience a complication during their stay than those without. Finally, of the six patients with fracture who returned for unplanned visits, four had their postoperative course complicated by infection. Other studies have shown that infection represents the most frequent reason for readmission in pediatric dog bite patients.[15] However, none to our knowledge have examined the relationship between infection and bone fracture in regard to not only increased LOS but also more complex inpatient stays and rates of return.

The above findings collectively suggest that patients presenting with a fracture may be more likely to have subclinical deep infection not easily identifiable at admission which only reveals itself hours to days later. The nature of canine oral flora and the penetrative mechanism of bite wounds, directly inoculating deep subcutaneous tissue or even muscle and bone, could contribute to a delayed clinical presentation of infection. Furthermore, the discrepancy of LOS and complications after long bone as opposed to facial fractures suggests that long bone fractures of the arm and leg, although much less frequent, may be indicative of more severe injury and may be more susceptible to delayed-presentation infection and osteomyelitis than facial fractures. The delayed presentation of dog bite-associated infections has been documented in the adult population, with one study showing a mean delay of 24 hours from bite to the first appearance of symptoms, whereas 25% of the study group had a delay of greater than 48 hours.[22] Importantly, much longer latency times of several days to >2 weeks have been documented in cases of bite-related osteomyelitis.[23]

Considering the potential for delayed presentation, high clinical suspicion for soft tissue infection and especially osteomyelitis is recommended on assessment of pediatric patients presenting with dog bite-associated fractures, even if typical signs of infection are not immediately obvious. Furthermore, physicians caring for the subset of patients suffering from long bone fractures of the arm or leg may wish to maintain a low threshold for initiation of antibiotics or infectious disease consult. Awareness of these relationships could lead to faster identification of early-stage infection or osteomyelitis resulting in prompt treatment, in an effort to reduce inpatient stays and lower rates of complication and readmission.

This study is limited by the nature of a single-institution patient pool, which is associated with inherent regional bias. In addition, the small sample size of some cohorts, in particular those with postoperative complications and return visits, limits statistical power. Future studies could offer stronger evidence of these relationships by expanding both the number and geographical spread of participants.

CONCLUSION

Pediatric dog bite patients who presented with any bone fracture or prior medical comorbidity were more likely to experience longer hospital stays. Fractures were also associated with more complex courses of care, postoperative complications, and higher rates of readmission. Although the facial region represented the largest proportion of fractures, long bone fractures of the arm and leg were associated with comparatively increased LOS and complication rates. Furthermore, postoperative complications were not associated with any visible infection at the time of admission.

These findings suggest that fractures in pediatric dog bites, particularly of the long bones, can be an underappreciated source of latent wound infection associated with late-presenting negative outcomes. Increased awareness of these relationships could lead to earlier detection and treatment of infection in this vulnerable population toward improving outcomes.

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