Dog Bites in Children: A Descriptive Analysis

Les morsures de chien chez les enfants : une analyse descriptive

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Abstract

Objective: To describe characteristics of dog bites and their treatment in a pediatric population including infection, medical specialties involved, rates of admission, and need for surgery. **Method:** Patients presenting with a dog bite to the emergency department of a tertiary care pediatric hospital between January 1, 2015, and June 30, 2017, were included. Details related to demographics, complications, consultations, and treatment were extracted from the patients' records. Descriptive statistics were performed and binary logistic regression was used to assess potential predictors of infection. **Results:** One hundred fifty-eight dog bite patients were identified. Most patients were male (53.8%) and less than 5 years of age (50%). Bites occurred most frequently in June (13.3%) and July (16.5%). The face was most commonly involved (42.9%), followed by the hands (12.6%) and the scalp (26.6%). Pit bulls (11.4%), Labrador retrievers (7.0%), and German shepherds (4.4%) were the most common offending breeds. Most bites were superficial (91.1%). Half were treated conservatively with dressings and petrolatum-based ointment, with 41.1% requiring simple primary closure. Ten (6.3%) cases necessitated primary repair in the main operating room under general anesthesia. More than half of patients were treated with prophylactic systemic antibiotics (55.1%). Plastic surgery was the most common service involved (24.7%). Seven (4.4%) patients developed an infection and there were no mortalities or long-term complications. Rates of infection did not differ between patients who did or did not receive prophylactic systemic antibiotics ($P = .88$). Regression analysis revealed no significant predictors of infection. **Conclusions:** Most dog bites are superficial and involve the head and hands. Infection rate is low, with no significant difference in infection rates between patients treated with or without prophylactic antibiotics.

Résumé

Objectif : Décrire les caractéristiques des morsures de chien et leur traitement auprès de la population d'âge pédiatrique, y compris les infections, les spécialités médicales en cause, le taux d'hospitalisation et la nécessité d'intervention chirurgicale. **Méthodologie :** Les chercheurs ont inclus dans l'étude les patients qui ont consulté à l'urgence d'un hôpital pédiatrique de soins tertiaires entre le 1^{er} janvier 2015 et le 30 juin 2017 à cause d'une morsure de chien. Ils ont extrait des dossiers des patients l'information liée aux données démographiques, aux complications, aux consultations et au traitement. Ils ont utilisé les statistiques descriptives et la régression logistique binaire pour évaluer les prédicteurs potentiels d'infection. **Résultats :** Au total, les chercheurs ont recensé 158 patients victimes d'une morsure de chien. La plupart étaient de sexe masculin (53,8 %) et avaient moins de cinq ans (50 %). La plupart des morsures s'étaient produites en juin (13,3 %) et en juillet (16,5 %). Le visage était le plus touché (42,9 %), suivi des mains (12,6 %) et du cuir chevelu (26,6 %). Les pitbulls (11,4 %), les Labrador retrievers (7,0 %) et les bergers allemands (4,4 %) étaient les principales races en cause. La plupart des morsures étaient superficielles (91,1 %). La moitié des patients a reçu un traitement conservateur à l'aide de pansements et d'onguent à base de gelée de pétrole. Ainsi, 41,1 % ont eu besoin d'une simple fermeture primaire. Dix cas (6,3 %) ont nécessité une réparation primaire sous anesthésie générale au bloc

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opératoire principal. Plus de la moitié des patients a reçu des antibiotiques systémiques en prophylaxie (55,1 %). La chirurgie plastique était le service le plus utilisé (24,7 %). Sept patients ont contracté une infection (4,4 %), mais aucun cas de mortalité ni de complications à long terme n'a été observé. Le taux d'infection n'était pas différent entre les patients qui avaient reçu ou non des antibiotiques systémiques en prophylaxie ($P = 0,88$). L'analyse régressive n'a révélé aucun prédicteur significatif d'infection.

Conclusions : La plupart des morsures de chien sont superficielles et touchent la tête et les mains. Le taux d'infection est faible, et la différence de taux d'infection n'est pas significative entre les patients traités avec ou sans antibiotiques prophylactiques.

Keywords

dog bite, epidemiology, pediatric, wound

Introduction

Dog bites in the pediatric population carry the potential for significant functional, psychological, and aesthetic consequences.¹⁻³ Injuries can be as minor as simple puncture wounds to life-threatening head and neck injuries.³ Of the estimated 4.5 million dog bites that occur annually in the United States, half involve children.^{4,5} The likelihood of a child sustaining a dog bite in their lifetime has been estimated at 50%, compared with 20% in the adult population.^{1,2,6,7} Although government legislation and personal precautions may decrease the likelihood of injury, the total number and financial cost of dog bites has been rising.⁸⁻¹⁰

Injuries from dog bites account for approximately 1% of all emergency department (ED) visits in the United States.⁵ Patients presenting with dog bites are typically discharged with minor wound care (eg, dressing, antibiotic petrolatum-based ointments, and bandages); however, a number of injuries do require surgical treatment from plastic surgeons and specialist services.¹¹ For plastic surgeons in particular, dog bite-related repairs are among one of the top 5 reconstructive procedures annually with over 28 000 performed each year in the United States.¹²

Although several American studies have examined dog bites in children, the Canadian experience with dog bites is unknown.^{1,2,5,6,11,13} We undertook a retrospective study investigating dog bites in patients below the age of 16 treated at a tertiary care pediatric hospital in Nova Scotia over a 30-month period. Our aims were to describe the various characteristics of dog bites in the pediatric patient including their severity, management, and sequelae.

Methods

Institutional ethics approval was obtained for this study. All patients under the age of 16 presenting to the Izaak Walton Killam Health Centre ED over a 30-month period (January 1, 2015, to June 30, 2017, inclusive) were included in the study, with a follow-up to August 31, 2017. Patients were identified using *ICD-10-CA (10th Edition)* code W54, corresponding to "bitten by dog." All ambulatory care and consultation notes, patient care documents, operative notes, and additional ED visits following the initial presentation in the ED were reviewed.

For each dog bite patient, the following variables were recorded: patient gender, patient age, year and season of dog bite, anatomic location of injury, dog characteristics (relation

to patient, dog owner present, circumstances of bite, and breed), wound characteristics (muscle involvement, soft tissue defect, vascular injury, nerve injury, and Lackmann classification), type of management (simple dressing, simple primary closure, complex primary closure, and main operating room [OR] repair), antibiotic prophylaxis (including type and duration), rabies prophylaxis, admission to hospital, duration of time in hospital, consult services involved, presence of infection (including time to infection, type, intervention required, and organism cultured), mortality, and the presence of long-term complications.

The Lackmann classification is an injury severity classification originally used to characterize animal bites of the face.¹⁴ For the purposes of this article, we used this classification for dog bites over the entire body. The name of the vessel or nerve was captured if there was a vascular or nerve injury. In terms of the type of management used to treat a dog bite, complex primary closure was defined as a closure of the lip or eyelid and any sort of local flap.

Univariate descriptive analyses were performed for all variables. The rate of infection between those who were prescribed and those who were not prescribed prophylactic antibiotics was compared using the χ^2 test. A binary logistic regression model was used to assess potential predictors of infection. SPSS version 24 was used for all analyses (IBM SPSS Statistics, Armonk, New York). A $P < .05$ was considered significant.

Results

A total of 158 pediatric patients were identified over the 30-month period of interest. As depicted in Table 1, most patients were male (53.8%) and less than 5 years of age (50%). The majority of dog bites occurred in 2016 (7.5%), with a greater frequency in June (13.3%) and July (16.5%).

The bite was most likely to be unprovoked (46.8%) and caused by a family pet (53.2%), with the dog owner present (51.3%; Table 2). The most commonly involved dog breeds were Pit bulls (11.4%), Labrador retrievers (7.0%), and German shepherds (4.4%).

In terms of injury characteristics, almost half of the dog bites injured the face (42.9%), with the next most common locations being the hands (12.6%) and scalp (12%; Table 3). Dog bites rarely resulted in muscular (8.9%), soft tissue (8.9%), vascular (0.6%), or nerve injuries (0%). The Lackmann classification indicated that the majority of dog bites were superficial in nature without the involvement of muscle (91.1%). A small

Table 1. Demographic Characteristics of Patients Presenting to the Izaak Walton Killam (IWK) Health Centre in Halifax, Nova Scotia, Canada, With a Diagnosis of Dog Bite Between January 1, 2015, and June 30, 2017.^a

Variable	Frequency (%)
N	158
Gender	
Male	85 (53.8)
Female	73 (46.2)
Age	
0-5	79 (50.0)
6-10	46 (29.1)
11-15	33 (20.9)
Mean (SD)	6 (4)
Year of dog bite	
2015	63 (39.9)
2016	75 (47.5)
2017	20 (12.6)
Month	
January	12 (7.6)
February	8 (5.1)
March	17 (10.8)
April	12 (7.6)
May	13 (8.2)
June	21 (13.3)
July	26 (16.5)
August	9 (5.7)
September	16 (10.1)
October	11 (6.9)
November	7 (4.4)
December	6 (3.8)

^aN = 158.

portion were deep injuries with the involvement of muscle (3.2%) or a deep injury with a muscle and soft tissue defect (5.1%). Only a single case involved a vascular injury (brachial artery; 0.6%) and no cases involved bone (Table 3).

Half of dog bite cases required conservative treatments (dressing, antibiotic ointment, or antiseptic; 50%), with a substantial portion requiring simple primary closure (41.1%; Table 4). Four (2.5%) cases required complex primary closure. Ten (6.3%) cases necessitated repair in the main OR and included the following: simple closure under general anesthetic due to age or inability to tolerate local anesthetic (n = 3), full-thickness skin graft (n = 2), saphenous vein graft to repair brachial artery (n = 1), flexor digitorum profundus repair (n = 1), repair of severed orbicularis oris and frontalis muscle (n = 1), digital amputation (n = 1), and major lip repair (n = 1; Table 4).

Over half of patients were treated with prophylactic antibiotics (55.1%; Table 4). The most common antibiotic used was amoxicillin/clavulanic acid (83.9%) with a mean duration of 6 ± 2 days. Rabies prophylaxis was required in 7 (4.4%) patients. Nine (5.7%) patients were admitted to hospital for an average of 2 ± 1 days. Plastic surgery was the most common service consulted (24.7%), followed by otolaryngology (3.2%) and infectious disease (1.3%; Table 4).

Seven (4.4%) patients developed an infection as a result of a dog bite with an average time of onset of 3 ± 1 days (Table 5).

Table 2. Dog Characteristics of Patients Presenting to the Izaak Walton Killam (IWK) Health Centre in Halifax, Nova Scotia, Canada, With a Diagnosis of Dog Bite Between January 1, 2015, and June 30, 2017.^a

Variable	Frequency (%)
Dog characteristic	
Family pet	84 (53.2)
Known to patient	47 (29.7)
Unknown to patient	23 (14.6)
Missing	4 (2.5)
Dog owner present	
Yes	81 (51.3)
No	18 (11.4)
Missing	59 (37.3)
Circumstances of dog bite	
Unprovoked	74 (46.8)
Provoked	42 (26.6)
Not documented/missing	42 (26.6)
Dog breed	
Pit bull	18 (11.4)
Labrador	11 (7.0)
German shepherd	7 (4.4)
Husky	6 (3.8)
Golden retriever	4 (2.5)
Shih Tzu	4 (2.5)
Golden doodle	4 (2.5)
Beagle	4 (2.5)
Rottweiler	3 (1.9)
Bulldog	3 (1.9)
Other ^b	17 (10.6%)
Missing	77 (48.7)

^aN = 158.

^bOther breeds include Boston terrier, sheltie, mastiff, poodle, Staffordshire, border collie, Doberman, Havanese, Great Dane, corgi, Chihuahua, greyhound, and duck toller.

Six (85.7%) of the infections were cellulitides, with 1 infection involving an abscess (14.3%). The majority of infections were treated with intravenous antibiotics (57.1%), and in most cases, the organism could not be identified (28.6%) or the data were missing (57.1%).

The rate of infection in those who were prescribed antibiotics was 4.6%, while the rate in those who were not prescribed antibiotics was 4.3%. There was no significant difference between these groups ($P = .88$). Hosmer-Lemeshow test was not significant ($P = 1.00$), indicating our model is fit. No significant variables predicted occurrence of infection. There were no mortalities or long-term complications (permanent nerve or tendon dysfunction) beyond cutaneous scarring as a result of the dog bites (Table 5).

Discussion

The goal of this study was to evaluate the characteristics of dog bites at a pediatric hospital ED in a Canadian province over a 30-month period in order to better define the breadth of the issue and, if necessary, help to develop interventions aimed at reducing their morbidity. Demographics, dog bite features,

Table 3. Injury Characteristics of Patients Presenting to the Izaak Walton Killam (IWK) Health Centre in Halifax, Nova Scotia, Canada, With a Diagnosis of Dog Bite Between January 1, 2015, and June 30, 2017.^a

Variable	Frequency (%)
Location of injury ^b	
Face	82 (42.9)
Hands	24 (12.6)
Scalp	23 (12.0)
Arms	21 (11.0)
Legs	21 (11.0)
Neck	7 (3.7)
Trunk	5 (2.6)
Genitals	3 (1.6)
Feet	3 (1.6)
Buttocks	2 (1.2)
Muscle involved	
Yes	14 (8.9)
No	144 (91.1)
Tissue defect	
Yes	14 (8.9)
No	144 (91.1)
Vascular injury	
Yes	1 (0.6)
No	157 (99.4)
Nerve injury	
Yes	0
No	158
Lackmann classification	
1 = Superficial injury without involvement of muscle	144 (91.1)
2 = Deep injury with involvement of muscle	5 (3.2)
3 = Deep injury with involvement of muscle and tissue defect	8 (5.1)
4 = A: Stage III in combination with vascular and/or nerve injury	1 (0.6)
5 = B: Stage III in combination with bone involvement and/or organ defect	0 (0)

^aN = 158.^bSome patients have >1 location of injury. Frequency calculated as a percentage of all injuries.

rates of infection, rates of hospital admission, complications, specialties involved, and the need for surgery were captured.

Our study identified a total of 158 dog bite patients over the 30-month period at our centre. Most were male and below the age of 5 and occurred in 2016. The face was most commonly bitten and Pit bulls were the breed most likely involved. Fortunately, most bites were superficial in nature, with only 10 cases requiring repair in the main OR. Approximately half of patients were treated with prophylactic antibiotics, and the overall rate of infection was 4.4%. Infection rate was not different between patients treated with and without prophylactic antibiotics and regression analysis did not identify predictors of infection.

Studies investigating the demographics of dog bites in the pediatric population have found that males are more likely to be bitten than females.^{1,5,15,16} Most studies indicate that males

Table 4. Intervention Characteristics of Patients Presenting to the Izaak Walton Killam (IWK) Health Centre in Halifax, Nova Scotia, Canada, With a Diagnosis of Dog Bite Between January 1, 2015, and June 30, 2017.^a

Variable	Frequency (%)
Intervention required	
Dressing/polysporin/antiseptic	79 (50.0)
Simple primary closure	65 (41.1)
Complex primary closure (rotational flap, lip repair, eyelid repair)	4 (2.5)
Main operating room	10 (6.3)
Prophylactic antibiotic use	
Yes	87 (55.1)
No	70 (44.3)
Missing	1 (0.6)
Antibiotic type used	
Amoxicillin/clavulanic acid	73 (83.9)
Clindamycin	6 (6.9)
Amoxicillin	2 (2.3)
Piperacillin/tazobactam	2 (2.3)
Septra	2 (2.3)
Cyklokapron	1 (1.1)
Doxycycline	1 (1.1)
Mean antibiotic duration in days (SD)	6 (2)
Rabies prophylaxis	
Yes	7 (4.4)
No	151 (95.6)
Admitted to hospital	
Yes	9 (5.7)
No	149 (94.3)
Mean duration of hospital stay in days (SD)	2 (1)
Services involved	
Plastics	39 (24.7)
Otolaryngology	5 (3.2)
Infectious disease	2 (1.3)
Other ^b	5 (3.2)
None	107 (67.7)

^aN = 158.^bOther services include orthopedics, cardiac surgery, urology, oral and maxillofacial surgery, and ophthalmology.

sustain approximately 60% of all dog bites, with ages 5 to 9 years having the highest incidence for both genders.^{1,5,15} Our study found similar results in terms of gender and ages most commonly affected, with a slightly younger cohort overall. Our study also parallels research that has found that dog bites occur more frequently in June and July.^{1-3,11} During the summer months, children and dogs are both more active, and the possibility of interactions is higher. Coming too close or running past a dog could trigger an unprovoked attack. It is logical that family pets are the most common offenders, as children are likely to spend a considerable amount of time with a pet found in the home. Children are also more likely to feel comfortable with a dog they know, therefore increasing the chances they could “provoke” the dog and cause an unfortunate encounter. In keeping with previous studies,¹⁷⁻¹⁹ we found that most injuries were the result of a family pet and occurred in the presence of an adult.

Table 5. Infection Characteristics and Complications of Patients Presenting to the Izaak Walton Killam (IWK) Health Centre in Halifax, Nova Scotia, Canada, With a Diagnosis of Dog Bite Between January 1, 2015, and June 30, 2017.^a

Variable	Frequency (%)
Infection	
Yes	7 (4.4)
No	151 (95.6)
Mean onset of infection in days (SD)	3 (1)
Type of infection	
Cellulitis	6 (85.7)
Abscess	1 (14.3)
Infection intervention	
Intravenous antibiotics	4 (57.1)
Oral antibiotics	3 (42.9)
Organism cultured	
Pasteurella	1 (14.3)
None	2 (28.6)
Missing	4 (57.1)
Mortality	
Yes	0
No	158
Long-term sequelae	
None	158

^aN = 158.

Our results are largely consistent with previous studies indicating that the face, neck, and head are the most common areas of injury.^{1-6,11,15,16} Interestingly, we found that the neck was only affected in 3.7% of cases and the hands were the second most affected part of the body at 12.6%. While the hands are most commonly injured in adults, often times children startle the dog involved and do not have time to react, thus causing a bite to the face.¹ Head and neck injuries are of considerable concern as this area has a number of critical anatomic structures, is of greater importance cosmetically, and has the potential to cause substantial emotional distress.¹

Fortunately, only a small percentage of dog bites in this study caused any significant muscle or neurovascular injury and there were no mortalities. The majority of cases could be treated by means such as a medical ointment and bandages. A study completed by Garvey and colleagues at a level 1 pediatric trauma centre over 74 months revealed that 29% of dog bite cases required treatment in the main OR.¹⁹ This figure is substantially higher than what was found in the present study, and other studies have found main OR rates ranging from 5% to 27%.^{1-3,17,20,21} Our rate of dog bite repair in the main operative room falls on the lower end of this spectrum and is likely due to a number of potential factors, including availability of sedation and anesthetic support in the ED, greater comfort performing procedures under local anesthesia, greater comfort in primary closure, or fewer severe injuries.

Plastic surgery is the most frequently consulted surgical service for the management of pediatric dog bites,¹⁴ with a history of strong dog bite prevention advocacy.²² Soft tissue injuries associated with dog bites can be particularly

challenging for plastic surgeons and carry a heightened risk of infection compared to many other animal bites.²³⁻²⁷ Although the rate of infection in our study was low at only 4.4%, other studies have reported rates approaching 10% in certain cohorts.^{17,18,27} Callahan found that the risk factors for infection in dog bites were age greater than 50 years, upper extremity injury, puncture wounds, and delays in seeking treatment.²⁷ Our study was not able to identify any risk factors for infection as our sample size for patients who developed an infection was small and there was a considerable range within variables that may have been predictors. Extent of debridement and irrigation have been shown to decrease the occurrence of infection but were not explored in our study.²⁷ Another possibility is that infections in our population may have been under-reported, with patients initially seen in our ED being seen and treated for subsequent infection in outside EDs; the likelihood of this is low; however, provincial referral patterns mean that the majority of children are seen in our centre. Previous studies have shown that infection rates vary considerably between geographic locations and patient populations, making it difficult to attribute infection rates to any one factor.^{2,4,5,27}

Literature concerning the utility of prophylactic antibiotics has shown that antibiotics are largely ineffective for decreasing rates of infection for dog bites.²⁸⁻³¹ Although some small studies have shown that antibiotic prophylaxis can decrease the risk of infection in “high-risk” dog bites, larger meta-analyses have not proven their efficacy.³² A meta-analysis completed by Cummings suggests that prophylactic antibiotic use should be limited to individuals who may be at a higher risk of infection due to vascular or bony involvement.³¹ Our study demonstrated that the risk of infection did not decrease with the use of prophylactic antibiotics, although we did not have sufficient power to determine a true association. As the majority of our cases were “low risk” in nature, this compliments existing research.

Dogs tend to bite out of fear or protection of their territory.³³ Although some dog breeds are thought to be genetically predisposed to aggression, the type of treatment and quality of care from the owner can have considerable influence on a dog’s demeanour.³⁴ In addition, research suggests that the ability to correctly identify the breed of a dog based on a visual basis alone is less than 30% accurate.³⁵ Although certain breeds may be more aggressive in nature, Pit bulls are consistently the most common offenders in several large studies.^{2,20,21,36,37} Pit bulls have been found to cause more serious injuries than other breeds due to their bite force and overall aggressive nature.^{11,15,38} Although breed information was missing for many cases (48.7%), of the cases in which the breed was recorded, Pit bulls were most frequently involved.

Preventative measures to decrease the risk of dog bites have historically included laws regulating dangerous dogs, enhanced animal control programs, and educational programs on canine behavior and responsible dog ownership.³⁹⁻⁴² Although legislation and animal control programs have not been adequately studied, educational programs have the ability to improve the ability of children to safely approach and engage with dogs.^{42,43} It is self-evident that parents ought

to use considerable caution if children are interacting with known aggressive breeds. Nevertheless, research concerning dog bite prevention is sparse and outdated. Preventative interventions should be properly evaluated to determine their efficacy in the pediatric population.

The strengths of this study include the use of a reliable data registry, large catchment area, sizeable time period, considerable follow-up for each patient, and investigating a public health problem that has been underinvestigated in Canada. The limitations of this study include its retrospective nature, potential for sample bias, the inability to accurately identify dog breeds, insufficient power to determine the true association between prophylactic antibiotic use and rates of infection, and likely underrepresentation of the true incidence of dog bites. Patients may have presented to other primary health-care providers like family doctors or simply not presented at all, so therefore would not be captured in the study. Consequently, our study may underestimate the true number of pediatric dog bites in our region. Given the recent media coverage of Pit bull legislation, patients may also have been more prone to label an offending dog as such. Additionally, future studies should try and assess the relationship between prophylactic antibiotic use and rates of infection with the necessary statistical power.

The results of this study have a number of significant implications. First, this is the largest study investigating the characteristics of pediatric dog bites at a Canadian hospital to date. Our results largely support studies in the United States and abroad while further characterizing the extent of injuries using the Lackmann classification. Secondly, our study shows that the use of prophylactic antibiotics is not associated with lower rates of infection in the pediatric population. Antibiotics can have a number of side effects, which can be more severe in young children, so clinicians should be judicious in prescribing them. Thirdly, our results can be used to inform policy surrounding preventative measures across Canada. Dog bites can cause considerable morbidity and utilizing evidence-based policy to address this issue is crucial to protecting the pediatric population.

Conclusions

This study is the largest to date to investigate the characteristics of dog bites in a Canadian pediatric population. Most injuries occurred in males below 5 years of age and involved the head and hands. Pit bulls were the most commonly identified breed and the majority of injuries were superficial in nature. Ten patients required surgical repair in the main OR. The rate of infection was 4.4%. Rates of infection were not different between patients treated with and without prophylactic antibiotics. This study can be used in the future to inform the use of prophylactic antibiotics and educational measures surrounding the prevention of dog bites in the pediatric population.

Declaration of Conflicting Interests

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