Brief Report

Antibiotic Management of Animal Bites in Children During the Methicillin-Resistant *Staphylococcus aureus* Era

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Children presenting to an emergency department following an animal bite were found to be at risk for infection if they had puncture wounds, crush wounds, or were bitten by a cat. Of the infected wounds that were cultured, methicillin-resistant *Staphylococcus aureus* was not isolated as a pathogen.

Key words. animal bite; MRSA; pediatrics

An important goal in the management of animal bites is the prevention of subsequent infections. Wound infections following an animal bite have been reported to occur in approximately 20% of dog bites and up to 80% of cat bites [1, 2]. Studies have identified cat bites, puncture and crush wounds, bites of the hand, and wounds occurring more than 12 hours prior to medical management as potential risk factors for the development of wound infections [1, 3, 4]. None of these studies have specifically evaluated risk factors for wound infections in children alone.

The American Academy of Pediatrics (AAP) has established standards of care in the management of animal bites to help treat and prevent infections. The recommended antibiotic for treatment and prophylaxis of animal bites in penicillin-nonallergic patients is amoxicillin/clavulanate. The increase in skin and soft-tissue infections caused by community-associated methicillin-resistant *Staphylococcus aureus* (CA-MRSA) has raised concerns about whether MRSA is an important pathogen in infections following animal bites [5]. Since no data have been published on animal bite infections during the MRSA era, this information is critical to determine whether amoxicillin/clavulanate should still be empirically used for prophylaxis and treatment of animal bite infections.

The objectives of this study were as follows: (1) identify risk factors associated with the development of infected wounds; (2) determine whether MRSA was an important pathogen among infected animal bite wounds; and (3) assess the adherence of emergency department (ED) clinicians with the AAP Red Book® guidelines.

METHODS

A single-center retrospective study was performed to describe the care for children presenting to a large children's hospital ED following an animal bite. Patients with an ICD-9 code for an animal bite (E906.x) presenting to the ED between January 1, 2005 and April 24, 2008 were included in the initial cohort. This time frame was utilized as it was the minimum amount of time necessary to obtain 1500 patient records. A convenience sample was then randomly selected from this group to form the final cohort.

Medical records were abstracted using a standardized data collection form to determine patient demographics, type of animal, location and characteristics of the wound, antibiotic use, complications, and outcome. Wound type was classified as superficial, puncture, deep, or crushing based on the written description provided by a nurse or physician. Patients were considered to have an infected wound if it was documented as overtly infected, had surrounding cellulitis or streaking, or had purulent discharge/drainage documented.

The criteria used to determine appropriateness regarding the choice of antibiotic and the duration of therapy was based on the American Academy of Pediatrics Committee on Infectious Disease's Red Book [6]. Antibiotic selection was considered to be appropriate if they received amoxicillin/clavulanate or trimethoprim/sulfamethoxazole plus clindamycin in cases of a penicillin-allergic patient. The duration of antibiotics was considered inappropriate if an uninfected wound received antibiotics for longer than 3 days.

Proportions were calculated for all outcomes. Fisher's Exact tests were performed on categorical variables to determine potential factors associated with the development of a wound infection following an animal bite. A multivariate logistic regression model was utilized to identify risk factors for the development of a wound infection due to an animal bite. A stepwise selection approach was employed for determining covariates in the multivariate analysis. Variables considered for inclusion in the model were type of animal bite (dog, cat, other), site of infection (trunk, face, extremities), and type of wound (superficial, deep wound, puncture, crush). Time to presentation was not included in the multivariate model as almost half of the patients did not have this information available. *P* values ≤.05 were considered statistically significant. All statistical analyses were performed using SAS® version 9.2.

Table 1. Demographics of Children With Infected and Noninfected Animal Bites

	Noninfected[a] (n = 690)	Infected[a] (n = 51)	*P* Value
Age			.2
< 1 year	11 (2)	0 (0)	
1–2 years	92 (14)	12 (12)	
3–5 years	144 (21)	11 (22)	
6–13 years	363 (53)	26 (51)	
>14 years	69 (10)	2 (4)	
Race/ethnicity			.018
Caucasian	411 (60)	41 (80)	
African American	171 (25)	6 (12)	
Hispanic/other	100 (12)	4 (8)	
Gender			.2
Male	389 (57)	24 (47)	
Attack animal			0.001
Dog	587 (85)	37 (73)	
Cat	60 (9)	13 (25)	
Other animal	40 (6)	1 (2)	
Wound location			.028
Face	335 (50)	20 (39)	
Extremity	299 (44)	31 (61)	
Trunk	40 (6)	0 (0)	
Wound type			<.001
Superficial	375 (54)	16 (31)	
Deep wound	81 (12)	5 (10)	
Puncture	204 (30)	22 (43)	
Crush	2 (0.3)	2 (4)	
Unknown	28 (4)	6 (12)	
Time from bite to ED presentation			<.001
≤12 hours	307 (44)	9 (18)	
>12 hour	49 (7)	30 (59)	
Unknown	334 (48)	12 (23)	

[a]ED, emergency department.

RESULTS

A total of 1500 children were initially identified during the study period. The convenience sample comprised 818 patients, of whom 77 patients were excluded due to nonbite injuries. Therefore, 741 children were included in our analysis. The majority of children presenting with animal bite wounds were 6–13 years of age and reported being bitten by a dog (Table 1). Overall, a majority of wounds were diagnosed to be superficial (53%). Bites primarily occurred on the face (48%), arms (31%) and legs (18%).

Among 51 infected patients, 15 (52%) of the 29 cultured had the following pathogens isolated: *Pasteurella multocida* (n = 10), methicillin-susceptible *S aureus* (MSSA) (n = 2), *Streptococcus pyogenes* (n = 1), and γ-hemolytic *Streptococcus* (n = 2). MRSA was not isolated from any of the wound cultures (n = 0; 95% confidence interval [CI], 0.000–0.119). Amoxicillin/clavulanate was the most common antibiotic used to treat these infected children (n = 23, 45%).

Factors independently associated with a wound infection following an animal bite were determined. In the final model, attack animal and type of wound were included. The greatest risk of infection occurred in children who had crush wounds (adjusted odds ratio [aOR], 27.9; 95% [CI], 3.6–213.1) and those bitten by cats (aOR, 4.1; 95% [CI], 2.0–8.6).

Antibiotic prophylaxis was provided for 451 (61%) patients. Amoxicillin/clavulanate was given in 384 (85%) of cases requiring prophylaxis, and the recommended alternative antibiotic regimen, clindamycin plus sulfamethoxazole/trimethoprim, was given in 9 (2%) cases. Therefore, 58 (13%) did not receive the appropriate antibiotic therapy. The other antibiotics used included cephalexin, cefdinir, and amoxicillin.

Duration of prophylactic antibiotic therapy was examined, and only 27 (6%) received the AAP recommended duration of 2–3 days. The lengths of therapy primarily prescribed were greater than 7 days (n = 244, 54%) and 4–7 days (n = 180, 40%).

DISCUSSION

In this study, we identified that crush wounds and cat bites were independent risk factors for the development of an infected animal bite. Furthermore, we did not identify any infected animal bite wounds due to MRSA, further confirming the choice of amoxicillin/clavulanate as the correct prophylactic and empiric treatment antibiotic. Finally, we observed that ED clinicians often utilize the correct antibiotic but their duration of prophylaxis is frequently longer than the AAP-recommended 2–3 days.

To our knowledge, this is the first study to identify independent risk factors associated with infected wounds exclusively in children. We identified crush wounds and being bitten by a cat as independent risk factors for developing a wound infection. Previous studies have suggested these as possible risk factors, but only one involving just dog bites performed multivariate modeling to identify independent risk factors [3, 4, 7]. In that study, female gender, need for wound debridement, and a full-thickness wound were identified as risks for infection [7].

Infections due to MRSA have been increasing in children [8, 9]. Among all of the *S aureus* isolates identified at our institution, 52%–57% were methicillin resistant during the study period, which is similar to the rates reported by adult institutions in the area. Since amoxicillin/clavulanate lacks activity against MRSA, it was important to investigate whether our animal bite wound infections were a result of this bacterium. Studies have identified *S aureus* as a pathogen in 10%–25% of cases [7, 10–12]. The largest prospective study of 107 infected dog and cat bites found that 11% were infected with *S aureus* [13]. None of these studies provide information on the susceptibilities of the *S aureus*, so the impact of MRSA is unknown. Among the 51 wound infections we observed, 2 were due to MSSA and none were due to MRSA, suggesting that amoxicillin/clavulanate is still appropriate for both prophylaxis and empiric treatment. Additional descriptive studies are needed in the CA-MRSA era to truly know the impact of MRSA on infected animal bite wounds.

Our study had several limitations. First, we performed chart review on a sample of the 1500 patients identified with an animal bite ICD-9 code during the study period. While we selected these cases randomly, it is possible that we failed to identify a large portion of patients that could have been infected. While our data are similar to other published reports on the risk factors causing an infected wound, we could have missed cases where MRSA was a pathogen. Second, since this is a retrospective study, some of the information needed to assess certain risk factors for infection from an animal bite was not documented. Specifically, we were unable to reliably ascertain whether a bite involved the hands and feet. Third, it is possible that some of the wounds that were treated for a prolonged course were actually infected but could not be verified due to documentation and the retrospective nature of this study. Finally, we lacked follow-up data that precluded us from identifying patients who were initially seen in the ED with an animal bite and then developed an infection. Our infection rate of 6.9% is significantly lower than previously reported 20%–80% infection rates and is possibly explained by the lack of these follow-up data.

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Potential conflicts of interest. All authors: No reported conflicts.

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