Mammalian Bite Injury: Current Concepts and Controversies in ED Management

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Abstract

Although mammalian bite injuries are very common in the ED, several aspects of their management remain controversial. This article summarizes current recommendations and evidence-based debates regarding the management of different types of mammalian bite wounds encountered in the ED, including irrigation and debridement, tetanus and rabies prophylaxis, and antibiotic prophylaxis. Dog bites usually cause abrasions, puncture wounds, or lacerations, whereas cat and rodent bites cause puncture wounds, and human bites, either occlusional or clenched fist injuries. Antibiotic prophylaxis is recommended in all cases of cat bites and almost all cases of human bites. It is usually not indicated for dog bites except in specific circumstances.

MeSH Words: Mammalian bite wounds, children, tetanus prophylaxis, rabies prophylaxis

INTRODUCTION

Mammalian bite injuries are commonly encountered in the emergency department (ED). The incidence may be expected to increase even further with the rising number of households in the western world that take in a mammalian pet – most frequently cats and dogs, but also hamsters and other rodents. Bites from humans, especially in preschool children and young adults, are also not unusual. This article discusses the evidence-based information, debates, and controversies ED physicians should be familiar with when treating victims of dog, cat, rodent, or human bites. Bite wounds from rarer mammalian sources such as monkeys require special consideration and are beyond the scope of this article.

Scope of the problem

Approximately 2- 4.5 million bites per year are treated by physicians in the US and up to 1% of all emergency visits are due to mammalian bites [1, 2]. In the United Kingdom, the annual number of people treated for dog bite wounds is about 250,000 [3]. The true incidence of dog bites is probably substantially higher, however, as many victims do not seek medical assistance. Most bites occur at home, and 82% of all

pediatric victims are familiar with the biting dog [2]. On average, 20 deaths per year from dog bites are reported in the United States [4,5]; about 65% of deaths occur in children less than 11 years old [5].

Cat bites appear to be less common, with approximately 400,000 per year reported in the United States [1, 2], mostly from household pets. Figures are not available on the incidence of rodent bites.

Human bites are the least common cause of serious mammalian bite injury, resulting is approximately 250,000 ED visits per year in the United States [1]. According to one study, human bites represented 0.04% of all pediatric ED visits from 1995 to 2001 [2]. Nevertheless, they are the leading cause of injury in daycare centers in the United States [5].

Type of bite wounds

Dog bites usually cause abrasions, puncture wounds, or lacerations, or a combination of these [2]. Tissue edema and crush injury may be significant, especially if the bite was inflicted by a large dog, interfering with the blood supply and wound healing. Large dogs can generate pressures in excess of 450 PSI, which is sufficient to penetrate and crush a human skull [2], especially an infant's.

Cats and rodents have long, sharp teeth that cause mainly puncture wounds [2]. These types of wounds are especially prone to infection, because the skin closes over the exit site, making debridement virtually impossible.

The hand is the most common site of cat and dog bites (60-67% and 45.3%, respectively) [2]; the face and neck are involved only occasionally (2% and 16%, respectively) [6]. Children are more likely than adults to be bitten on the head, neck, or face (OR 6.7, 95% CI 5.2-8.6) [7].

Human bites usually cause either occlusional injuries (wherein teeth sink into the flesh) or clenched fist injuries (when teeth meet fist). In the pediatric population, occlusional injuries generally occur in toddlers in daycare and are most often superficial. In other age groups and settings, such as rough sex play, domestic violence, and child abuse, as well as during a fall or seizure-related injury [2], human bite wounds may be deep and significant. Clenched fist injuries are typical to adolescents and young adults who engage in fistfights. They usually occur on the third, fourth, and fifth metacarpophalangeal joints, and sometimes to the proximal interphalangeal joints. Although all human bites are considered to harbor a risk of infection, clenched fist injuries have the highest risk for several reasons: the proximity of the bones, joints, and tendon sheaths to the surface; the difficulty in debriding the infected compartment as the hand unclenches and seals it off; and the tendency of these victims in particular (owing to the circumstances of the injury) to seek medical attention late after the infection is already established. Some investigators [8] question whether the heightened risk of infection in this case stems from the presence of human oral flora in the wound or from the circumstances: the usual location of the bite- in the hand, and the delay in seeking medical attention.

Primary evaluation and treatment

When obtaining a patient's history after bite injury, the ED physician must direct careful attention to the factors that could increase the risk of infection, such as immunosuppression and lymphatic obstruction. Regarding the biting animal, attempts should be made to determine its immunization history and the circumstances surrounding the bite itself: presence or absence of provocation, did the bite occur through clothing (thus reducing the chance of contact with the animal's saliva), and how long ago did it occur.

In the management of bite wounds, the most important measures to control infection are irrigation and debridement. Current guidelines recommend sponging away visible dirt and then washing the wound vigorously with large amounts of sterile saline using high-pressure syringe irrigation [1]. Irrigation is particularly important if the animal is suspected of being rabid. This procedure is followed by gentle debridement to remove the virus from the wound edges [3]. Studies have shown that the early application of a viricidal agent such as povidone-iodine after a rabid animal bite can decrease the risk of rabies infection [2, 3]. However, when rabies is not a primary concern – which is most cases - antimicrobial or anti-infective solutions should not be used because they have no added

advantage and they may irritate the wound tissue [1]. In instances in which the wound is visibly infected, extensive devitalized tissue is present, or the wound involves the cranium or the joints of the hand (clenched fist injury), surgical debridement with or without reconstructive surgery may be required [1, 9].

In bite wounds to the limbs, another major intervention is limb elevation and immobilization to reduce edema and, thereby, the risk of infection [3]. Some providers also advocate steroid treatment for this purpose [10]. X-rays should be performed in cases of penetrating injury overlying bones or joints (usually on the hands or feet and, in the case of big dogs and small infants, the skull) in order to detect bone fractures. The presence of significant tissue damage may also warrant x-ray to rule out foreign bodies (teeth) [1].

Are wound cultures necessary?

Bite wounds are always contaminated, and this contamination is polymicrobial, but they are not necessarily infected. Cultures of infected bite wounds yield an average of 5 isolates of both aerobic and anaeorobic pathogens [6]. The most common pathogen in dog bite wounds is *Pasteurella canis,* isolated in 50% of cases in one study; the most common pathogens in cat bite wounds are *P. multocida subsp. multocida,* and *septica,* isolated in 75% of cases [6]. *Pasteurella* can cause severe infections that spread rapidly, usually within 12 hours of the bite.

Routine culture for cat and dog bites is not recommended, as it has no predictive value. However, when there is a particularly high risk of infection, for example, if the host is immunocompromised or the wound is more than 8 hours old, cultures should be taken before the administration of antibiotic treatment. For human bites, some investigators suggest culture in all cases, maybe due to the high infection risk [4]. In patients with obvious infection, gram staining and culture should precede antibiotic treatment. Punch biopsy near the bite wound may be indicated, in some cases, when infection is apparent but a good culture specimen cannot be obtained from the wound (such as a puncture or closed-fist wound) [1]. The laboratory should be notified that wound cultures were derived from a bite wound, as both aerobic and anaerobic cultures are needed, and some of the organisms may be fastidious and slow-growing.

Should we suture? Primary versus delayed closure

The proper means of bite wound closure remains controversial, especially when cosmetic concerns are high. As bite wounds are essentially contaminated, meticulous debridement and delayed closure appear to be the obvious choice. Supporters of this method claim that as long as the repair is performed before the wound reaches the proliferative phase of healing, cosmetic results are indistinguishable from those of primary repair (2, 3). However, there is accumulating evidence that in certain bite wounds- some say even in most- primary closure yields the best cosmetic result without significantly increasing wound infection rate (9). When deciding on the method of wound closure, the physician should consider the infection risk, taking the following characteristics into account:

Type of wound. Lacerations are easily cleaned and debrided, whereas puncture wounds are virtually impossible to clean, as noted before. In occlusional bite injuries, especially those made with great force, crush injury might be a significant factor, compromising the local blood supply and harming deeper structures. The physician should carefully inspect the wound and try to eliminate all devitalized tissue and foreign bodies. Full-thickness wounds involving tendons, ligaments, and joints, and wounds that were previously sutured, are also at greater risk of infection [3].

Location of wound. Limbs pose a greater risk of infection than the face and neck, as previously mentioned, owing to the limited local blood supply and possibility of injury to deeper structures. Cosmetic considerations are more important in the face and neck.

Time to medical attention. Most authors agree that bite wounds that remain untreated for 6-8 hours are subject to significant infection. Therefore, patients who present more than 8 hours after the incident should be strongly considered for delayed closure, unless this option is outweighed by cosmetic concerns.

Other patient-related factors. Additional factors that can increase the risk of infection are

discussed in the section on antibiotic prophylaxis.

It is common practice today to treat bite wounds of the face by primary repair. Current data suggests that most mammalian bites in the limbs can also be sutured, and even constructive procedures can be performed [9] with an infection rate of 6-7%, which may be acceptable when cosmesis is a primary concern [11]. Others still advocate avoidance of primary repair of limb bite wounds where possible, because of increased risk of infection [3]. Another approach would be to avoid suturing, as it might increase the infection rate, and to perform debridement and then approximate wound edges using adhesive tapes or tissue adhesive [1].

Tetanus prophylaxis

The usual guidelines of tetanus prophylaxis are applicable to mammalian bite wounds. Tetanus/diphtheria/pertussis (Tdap) or diphtheria/tetanus (dT) vaccine should be administered to all patients who last received a vaccination more than 5 years previously. Tetanus immune globulin is added in those with significant bite wounds if the tetanus immunization history is unknown or if fewer than 3 doses of tetanus vaccine were administered previously [1].

Rabies prophylaxis

Rabies is nearly always fatal. Rabies prophylaxis should be considered in all cases of mammalian bites. In Israel, patients are referred to the local health department, where the incident is registered, the wound is examined, and a complete history of the incident and of the biting animal is obtained. District health offices in Israel see 16,000-20,000 persons annually for bite wounds from various animals [12].

To determine the need for prophylaxis, familiar dogs are quarantined for 10 days and if they die, autopsy will be performed for signs of rabies and the victim vaccinated accordingly. Stray dogs pose a greater risk, and if they are not trapped and quarantined, the need for prophylaxis is determined according to local epidemiologic data. Cats pose almost no risk of rabies in Israel, and small rodents are considered rabies-free. Bigger rodents, and especially wild mammals, should, if possible, be killed and autopsied immediately; if they are not caught, rabies prophylaxis is administered [12].

When rabies vaccination is deemed necessary, rabies immune globulin is administered in the ED. All or as much of possible of the vaccine should be injected in the bite wound and the rest given intramuscularly. Active vaccine is administered (in Israel, at the local health department) intramuscularly on days 0, 3, 7, 14 and 28 after exposure [1].

Antibiotic prophylaxis

Since bite wounds are always contaminated, infection is a major concern. Several questions should be raised regarding the need for prophylactic antibiotic administration: Is there a risk of infection? Does the risk justify prophylaxis: Is the rate of infection high, and is the infection likely to spread systemically or to remain localized? Is prophylaxis efficient in preventing infection? What antibiotics should be administered for the prophylaxis to be efficient? What is the price of prophylaxis in terms of cost and side effects? Some of the answers are provided below.

Is there a risk of infection?

Bite wounds are always contaminated by the multiple microbes present in the normal oral flora of the biting animal and the victim's own skin. These bacteria are pathogenic to humans and may cause severe infections. As mentioned, *Pasteurella* is considered a major pathogen in cat and dog bites and causes a severe and rapid (usually less than 12 hours from the bite) infection [3].

Is the infection rate high enough to justify antibiotic prophylaxis?

A low incidence of infection would suggest it is better to treat only the infected wounds and avoid unnecessary antibiotic administration to most patients. Some bite wounds, especially feline and human, are associated with relatively high infection rates (up to 80% and 17.7%, respectively) [2], exceeding the reported rates for simple lacerations. For dog bites, however, the wound infection rate is about equal to that for non-bite lacerations. Some investigators suggest that children might be at higher risk than adults. In a recent study from Germany, of the 8 patients

with infections out of 132 who presented with facial bite wounds, 6 were children and only 2 were adults [13]. Therefore, the authors suggested that antibiotic prophylaxis be administered to all pediatric mammalian bite victims.

Is infection likely to be local or to spread systemically?

Even in the presence of a relatively high rate of infection, if the infection tends to be low grade, a reasonable approach would be to debride the wound as best possible and watch for early signs of infection; if they appear, treat with antibiotics immediately. This would again prevent treating the majority of patients, thereby avoiding side effects and lowering costs.

As most bite wound infections are local, they can be easily controlled if treated early. However, infections can become systemic and even fatal, especially in immunocompromised hosts, such as patients with malignancies or immune deficiencies, or small babies. Furthermore, mammalian flora contains *Capnocytophaga canimorsus* that can cause systemic infection in patients with asplenia or cirrhosis, but also, in some cases, in healthy hosts. Therefore, the watchful approach of treating only at the appearance of signs of infection may not suit all cases of mammalian bite injury.

Can antibiotic prophylaxis prevent the development of infection?

Only a few randomized controlled studies of the efficacy of antibiotic prophylaxis have been performed to date, and most were methodologically flawed, comparing bites from multiple animal types treated with different antibiotic regimens. Moreover, each contained only a small number of patients in each group, with a low rate of infection, and the follow-up in most studies was usually insufficient (<90% of patients were contacted or seen after their ED visit). Following is a summary of the currently available evidence-based information.

Dog bites

Two major studies have summarized the current information on antibiotic prophylaxis in dog bites. Cummings et al. [14], in a meta-analysis in 1994, found that prophylactic antibiotics reduce the incidence of infection (RR 0.56, 95% CI 0.38-0.82). The NNT (number of patients needed to be treated) to prevent one infection was 14. However, 7 years later, the Cochrane collaboration [15] reached the opposite conclusion, namely, that prophylactic antibiotics do not appear to reduce the rate of infection (OR 0.74, 95% CI 0.30-1.85). The Cochrane review analyzed, in the context of dog bites, basically the same studies as Cummings and colleagues [14], but applied different methods of data extraction and statistical analysis. It also excluded 2 studies, one of which was the only trial that had used amoxicillin-clavulanate prophylaxis. The authors of the Cochrane review suggested caution when interpreting their results, as there was significant heterogeneity in the meta-analysis [15].

Cat bites

Most authors agree that cat oral flora is pathogenic to humans, and due to its high infection rate, recommend treatment. The Cochrane review found no advantage to prophylactic antibiotic administration for cat bite [15]. However, its conclusion was based on a single study with 12 patients (one of whom failed to return for follow-up), and the antibiotic used was oxacillin, which is inactive against most *Pasteurella spp.* and all anaerobic microorganisms. Nevertheless, the infection rate in the control group was 67% (4/6) and zero (0/5) in the treatment group. Considering these findings, along with the fact that most cat bites are puncture wounds that are virtually impossible to fully debride, antibiotic prophylaxis would seem to be indicated.

Human bites

Infection rates are high in human bites. The Cochrane review found that "the use of prophylactic antibiotics was associated with a statistically significant reduction in the rate of infection after bites by humans" [15]. Again, however, this recommendation was based on the findings of a single study. In 2005, the question of human bite wound infection was addressed by the Best Evidence Topic reports [16]. Their review of the English literature yielded only 2 relevant studies: one showed a clear benefit of prophylaxis for human bites to the hand, and the other found no advantage in superficial bite wounds. The authors concluded that prophylactic

antibiotics should be given to all patients with human bites to the hands, feet, and skin overlying joints or cartilaginous structures, and in all cases of human bites that penetrate deeper than the epidermal layer [16].

Both Cochrane and Cummings tried to establish whether antibiotic prophylaxis is effective in preventing infections in bites to the hand (high risk for infection). Both found that antibiotic prophylaxis seems to be protective. Cummings (14), found the relative risk to develop infection in those receiving antibiotic prophylaxis versus those not thus treated was 0.23 (95% CI 0.05-0.95). Cochrane also found significant reduction in rates of infection in the treated patients (OR 0.10, 95% CI 0.01-0.86) and the number needed to be treated (NNT) was 4 (95% CI 2-50) (15). Cochrane also tried to establish an advantage to prophylactic treatment in puncture wounds as opposed to lacerations, but found none (15). Cummings (14) tried to analyze the utility of antibiotic prophylaxis in sutured wounds versus non-sutured, but as there were only 2 studies with data for this subgroup analysis, the numbers were too small to allow useful conclusions. Overall, as mentioned before, these major summary articles are problematic because of the flawed methodology and limited number of the studies they are based on.

Most authors agree that in the presence of a high infection risk, such as bite wounds to the hand, immunocompromised individuals or delayed presentation for medical attention, antibiotic prophylaxis should be administered.

What antibiotic should be administered?

As previously discussed, randomized controlled trials are few, and different antibiotics were given.

For animal bites, prophylactic treatment should be active against *Pasteurella*, *Streptococcus, Staphylococcus,* and anaerobes, most of which are beta-lactamase producers. For human bites, prophylactic antibiotics should be active against *Streptococcus, Staphylococcus, Eikenella,* and anaerobes [2]. The usual antibiotics prescribed for skin infections, namely, anti-staphylococcal penicillins, first-generation cephalosporins, clindamycin, and erythromycin, may not be sufficient [1]. Until recently, all pathogens isolated from mammalian mouths and bite wounds were susceptible in vitro to amoxicillin-clavulanate, making it the first choice for prophylaxis. However, only one clinical study of the efficacy of amoxicillin-clavulanate (Augmentin) has been conducted so far, with good results [17]. Although the skin flora of patients in several areas of the world might contain methicillin-resistant *Staphylococcus aureus* (MRSA), which is not adequately treated by amoxicillin-clavulanate, there is insufficient information at this time to change this recommendation. Hospitals in areas to which MRSA is endemic should establish their own protocols in accordance with local in vitro antibiotic susceptibilities. For patients allergic to penicillin, current recommendations are shown in Table 1 [18]. Azithromycin has good in vitro activity against all bite wound pathogens, but it has not been used in clinical practice.

Antibiotics are usually administered for 4-5 days, although 2-3 days may be sufficient if treatment is started no later than 8-12 hours after the bite, and no infection is apparent after 48-72 hours [1].

According to current recommendations, prophylactic antibiotic treatment for dog bites should be administered under the following conditions [1]:

- Moderate or severe wound, especially with significant edema or crush injury
- Puncture wound, especially if it penetrates bone, tendon sheath, or joint
- Facial bite wound, especially oro-cutaneous ("through-and-through") [3]
- Wound to the hands or feet
- Wound to the genital area
- Immunocompromised host (including patients with diabetes, cirrhosis, or local vascular and lymphatic disease)

Some researchers recommend administering antibiotic prophylaxis for all bite wounds after primary closure [3]. Treatment should, of course, be administered also in cases of obviously infected wounds.

Whether antibiotic prophylaxis is administered or not, it is crucial to check the wound again in 24-36 hours, as infection can be severe and even life- threatening.

Table 1. Recommended prophylactic antibiotic treatment for mammalian bite wounds (adapted from ref. 18)

Source of bite wound	General recommendation	Penicillin-allergic patients
Dog*	Amoxicillin-clavulanate	***Adults:*** **Clindamycin + fluoroquinolone** ***Children:*** **clindamycin + trimethoprim-sulfamethoxazole**
Cat	Amoxicillin-clavulanate	**Cefuroxime-axetil or doxycycline**
Human	**Amoxicillin-clavulanate**	**Clindamycin + ciprofloxacin, or clindamycin + trimethoprim-sulfamethoxazole**

* Prophylactic antibiotics for dog bites are given only when indicated- see text.

Other infectious considerations

Besides bacterial infections, hepatitis B and human immunodeficiency virus infections can be transmitted via human bites. If the risk is considered significant, post-exposure prophylaxis might be indicated. Cat bites may also cause cat scratch disease, and rodent bites, tularemia and rat-bite fever. The treating physician in the ED should bear these possibilities in mind and watch for them, although targeted prophylactic treatment is usually not given.

Summary

This review summarizes the current debates and recommendations in the treatment of bite wounds in the ED. The cornerstone of treatment remains good local wound care including irrigation and debridement, with tetanus and rabies prophylaxis as necessary. Antibiotic prophylaxis is recommended in all cases of cat bites and almost all cases of human bites, with the exception of superficial occlusion injuries. It is usually not indicated in dog bites except in specific circumstances. Some issues are still controversial because of the lack of good randomized studies. The treatment modality in individual cases is determined by the physician's experience and local protocols.

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