

Practical Review of the Management of Animal Bites

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Background: Animal bites are common worldwide. Due to the plethora of animals, there are diverse pathogens with specific associated risks and treatment algorithms. It is crucial to understand these to develop and execute appropriate management plans. This practical review was designed to amalgamate the most common bites worldwide and synthesize data to help guide treatment plans.

Methods: A PubMed literature search was performed focusing on the major animal bites. High-level studies were preferred and analyzed but lower-level studies were also used if high-level studies did not exist.

Results: The tables presented in this article cover the pertinent information regarding the incidence, common presentation, initial treatment, and potential complications associated with bites from dogs, cats, horses, rodents, snakes, marine life, and spiders. Many of the pathogens associated with the bites are treatable with various and somewhat common antimicrobials, though some are less easy to access. Basic irrigation, debridement, and wound culture are common to almost every animal and should be the first step in treatment.

Conclusions: Based on the current studies, the most important factor in treating animal bites is timely presentation to a medical facility and/or physician. It is critical that the offending animal be accurately identified to help guide medical and surgical algorithms, including specific antimicrobial treatment guided by the most commonly presenting pathogens specific to certain animals. (*Plast Reconstr Surg Glob Open* 2021;9:e3778; doi: [10.1097/GOX.0000000000003778](https://doi.org/10.1097/GOX.0000000000003778); Published online 9 September 2021.)

INTRODUCTION

Animal bites are a common indication for medical care both in the United States and worldwide, accounting for approximately 1% of emergency department visits and more than 50 million dollars in annual healthcare costs in the United States alone.¹ Although the initial evaluation of a patient presenting with an animal bite follows a similar sequence, the precautions and subsequent management of various types of bites should be specific to the bite origin.¹

The existing literature on animal bites reveals that various types of bites have different risks, management algorithms, and potential complications. Review and synthesis of the standing literature may assist in the comparison of various animal bites to better understand both the

underlying commonalities of basic treatment and important clinical pearls that differentiate specific bites. Timely intervention is essential in mitigating symptoms and reducing complications.

This article will discuss the incidence, common presentation, treatment, and potential complications associated with the most frequent types of bites encountered. These bites include those of dogs, cats, horses, rodents, snakes, marine life, and spiders.

METHODS

Using the PubMed database, a literature search was performed with the inclusion criteria of English Language AND 1990-Current AND Humans for the following individual MESH terms: Bites and Stings, Dogs, Cats, Equidae, Sharks, Alligators and Crocodiles, Fish, Rodentia, Rats, Rabbits, Guinea Pigs, Mice, Snake Bites, Snakes, Spider Bites, and Spiders. The results were further screened manually to initially exclude those that were not accessible, beyond the scope of this article or not meeting level I or level II study criteria as described by the American Society of Plastic Surgeons.² Level I studies (n = 68) were defined as therapeutic randomized controlled trial, high-quality prognostic prospective cohort studies or systematic reviews of these study types.² Level II studies (n = 20) were

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defined as low-quality therapeutic randomized controlled trial, nonrandomized therapeutic prospective studies, low-quality prognostic prospective studies, prognostic retrospective cohort studies, or a systematic review of the described study types.² For any topics in which this level of evidence was unattainable, lower-level resources were included ($n = 3$). The data were analyzed and overarching themes were synthesized to provide a scoping review on the topic of animal bites.

Dogs

Dog bites account for approximately 85%–90% of animal bites in the United States, with an estimated 800,000 of these bites presenting for medical attention annually.³ The most affected populations are male youths, particularly those with behaviors that elicit or trigger aggressive actions in dogs.^{4,5} Such behaviors include physically harassing the dog and trying to take the dog's food. Injury rates have been shown to decrease with increasing age.⁴ Most bites are reported in the setting of warm weather, during the evening and in the home environment, with single-parent homes showing increased risk.^{6–8} Commonly implicated breeds include pit bulls, shih tzus, German shepherds, Dobermans, Alsatian mixes, and rottweilers.^{9–11}

Age of the affected individual may stratify the presentation of bite wounds by incident location, severity, and body region.¹² Children are more likely to suffer bites and bites of greater severity, as demonstrated in one study by a correlation of -0.80 between increasing age and bite frequency.^{13,14} Populations under the age of five are more likely to present with head and neck injuries, incurred indoors and with a familiar dog (often belonging to the family).^{14,15} Current data suggest that pit bulls are the most dangerous for children younger than 18, whereas dachshunds and shih tzus are possibly dangerous for children younger than 3 years.^{13,14} In contrast, adolescents and adults are more likely to suffer injuries to the extremities, occurring outdoors and more often by interactions with unfamiliar dogs.^{14,15} Dogs with larger teeth are expected to yield more crush injuries that lead to lacerations and superficial abrasions rather than puncture wounds, which are more common in smaller dogs.¹⁶

Treatment of dog bite wounds is largely predicated on the location of injury and time of presentation.¹⁷ The “risk” of the injury is based on the likeliness of infection and is dependent on the victim, species, depth, overall tissue destruction, joint involvement, and location of bite. High-risk bites are typically deeper and more destructive, whereas low-risk bites are neither deep nor destructive.¹⁸ Upper extremity wounds are more likely to require surgical intervention and most prone to develop infection.¹⁷ Additionally, patients presenting 1–2 days post bite carry a 3.5 and 7 times increase in the relative risk of hospitalization or surgery, respectively compared to patients presenting the same-day.¹⁷ All wounds, and in particular those requiring subsequent primary closure, should undergo high-pressure irrigation¹⁹ and debridement.¹⁶ Primary wound closure has been demonstrated to be superior for injuries in aesthetically sensitive areas such as the face as compared to healing by secondary intention.¹⁶ It remains

controversial whether primary closure poses a slightly increased risk of infection, but most randomized clinical trials have concluded that infection rates for primary and secondary closures are equivalent at 40%.^{16,17,20–22} All studies comparing modalities of treatment have demonstrated that primary closure yields faster healing and superior cosmetic outcomes, as quantified by reduced scar size and appearance.^{20–22}

Prophylactic antibiotic treatment of dog bite wounds remains controversial, but rabies postexposure prophylaxis (PEP) is largely unindicated in low-risk bites.^{23,24} In a meta-analysis of randomized trials, it was found that approximately 14 patients must be treated to prevent infection from one dog bite wound.²⁵ Circumstances in which rabies PEP may be indicated include upper extremity bites in children, puncture wounds, and wounds those with a laceration length of greater than 3 cm.^{17,24,26} Rabies PEP may also be of use in residents and travelers of areas with endemic rabies disease, where Rabies PEP.^{27,28} Education of healthcare providers is crucial to the success of treatment.^{27,28} In one study conducted in Haryana, North India, PEP was known to only 18.8% of healthcare professionals (HCPs) and only 59% of HCPs were confident in managing dog bites.²⁹ Other barriers to the success of rabies PEP include cost, failure of compliance to complete PEP, delay in medical presentation, and use of prehospital treatments, which is directly associated with a delay in seeking medical treatment.^{29–34} Failure to comply with rabies PEP has been associated with location of residence, male sex, ages 15–49, time of year, and duration of PEP protocol.³² Likewise, delayed access to care has been associated with age older than 15 years, residence in rural areas, and the rainy season.³⁴ Rabies infections following dog bites are most commonly cited in lower extremity injuries and associated with residence in developing countries, residence in rural areas, male gender, warm weather, and dry season.^{34–37}

Other common sequelae include lacerations, fractures, arterial injuries, amputations, and arthritis.^{38,39} Most sequelae are of cosmetic nature and associated with female gender, larger dog weight, and severity of dog bite injury.⁴⁰ Children are 4.2 times more likely to sustain ocular injuries as well as facial trauma as compared to adults.^{41,42} Periocular injuries should be evaluated for canalicular laceration and fracture of periorbital and nasal bones, as these structures are commonly implicated.^{41–43} Complications following facial injury include facial nerve damage, lacrimal duct damage, ptosis and ruptured globe, and blood loss requiring transfusion.^{41,42} More serious complications also reported include osteomyelitis, sepsis, neurological injuries, and death.^{38,39} Common pathogens and treatments are presented in [Table 1](#).

Cats

Cat bites also contribute a significant portion to the total of animal bites observed, with incidence varying significantly depending on location. For instance, New York City Emergency Department data report that cat bites constitute approximately 13% of all bites, second only behind dogs (70%),⁴⁵ whereas in Dallas, Texas, it is 25%.⁴⁶

Table 1. Common Pathogens and Subsequent Treatment of Dog Bites

Pathogen	Recommended Treatment	Timing	Route of Administration	Dosage	Notes
<i>Pasteurella canis</i>	Beta lactam ⁴⁴ (eg, penicillin) Beta lactamase inhibitors ⁴⁴ (eg, tazobactam) Aggressive broad-spectrum antibiotics ⁴⁴	2 to 3 times a day with accompanying meal	Typically oral administration	25–50 mg for children; 250–300 mg for adults	Aggressive broad-spectrum antibiotics used only if infection is advanced
<i>Streptococci</i> and <i>Staphylococci</i>	Beta lactam ⁴⁴ (eg, penicillin) Beta lactamase inhibitors ⁴⁴ (eg, tazobactam)	2 to 3 times a day with accompanying meal	Typically oral administration	25–50 mg for children; 250–300 mg for adults	
<i>Capnocytophaga canimorsus</i>	Beta lactam ⁴⁴ (eg, penicillin) Beta lactamase inhibitors ⁴⁴ (eg, tazobactam)	2 to 3 times a day with accompanying meal	Typically oral administration	25–50 mg for children; 250–300 mg for adults	

The exact percentage varies between countries worldwide (Table 2).^{46–50,53}

Environmental factors associated with increased bite incidence include high humidity and summer months.^{46,49,53} Cats represent a larger portion (89.4%) of provoked attacks as compared to dogs, with additional features of Siamese breed, female gender, and domestic status increasing the risk of attack.^{50,54} In contrast to dogs, cat bites are largely inflicted by the owner's own cat regardless of age of the victim.⁵⁵ Additional victim characteristics associated with increased prevalence include female gender and older age.^{26,48,50,53}

Cat bites commonly present as a single puncture, often on the hand or arm (91%).^{49,56,57} Of hand injuries, the index finger is the most common site of injury (45%).⁵⁷ Across all animal bites, nonpurulent wounds with lymphangitis are most associated with cats.⁵⁸ Risk factors for subsequent hospitalization include smoking, immunocompromised state, location of bite over a joint or tendon sheath, and initial physical findings of erythema and swelling.⁵⁹ The initial treatment of cat bite wounds is similar to dog bites, entailing irrigation,¹⁹ debridement, wound culture, and assessment of tetanus and rabies risk.^{51,52} However, the primary closure of cat bites is not recommended due to the deep penetrative nature and increased contamination rate associated with these wounds.^{51,60} Initial surgical debridement is of increased importance and in one study was shown to reduce the positive bacterial smear from 62% to 13% postprocedure.⁶⁰ Plain radiographs should be obtained if bone or joint involvement is suspected.⁵² Lacerations may be closed after a waiting period of 4–5 days with elevation, immobilization, and intensive physiotherapy implemented in all hand bites.^{51,59}

Table 2. Percentage of Bites Caused by Cats in Locations Worldwide

Location Observed	Percentage of Bites Caused by Cats (%)
France ⁴⁷	16.8
Italy ⁴⁸	19.7
Spain ⁴⁹	8
Switzerland ⁵⁰	25
Turkey ⁴⁶	7.5
United States ^{51,52}	3–15

Complications of cat bites include wound infection, development of rabies infection, and lymphadenopathy (cat scratch fever).^{1,28,50,56} Wound infection following cat bites is of greatest concern, as it is more common following bites by cats (30.8%) than by dogs (8.5%).^{50,56,57} The microbiological profile of these bites is commonly a mixed aerobic and anaerobic infection (63%), with *Pasteurella multocida* being present in 70% of all infections.^{52,56,58,61} *Pasteurella* usually indicates symptoms often within 3 hours of attack.^{56,61} Infection often presents with cellulitis with accompanying erythema (89%), severe pain (83%), edema (77%), and fever (18%) within 3 hours of the biting incident.^{56,61} Tenosynovitis, arthritis, abscess, and septicemia have also been reported (18%), as well as osteomyelitis, pneumonia lung abscesses, and empyema.^{56,61} Common pathogens and treatments are presented in Table 3.

Snakes^{66,67}

Factors associated with increased snakebite prevalence include field labor, male gender, middle age, lower education status, low income, and residence in rural areas.^{66,68–77} Associated environmental factors include monsoon season and evening hours.^{71,73,78,79} In the United States, increased biting rates have been reported in the locations of Texas, Florida, West Virginia, Oklahoma, and Louisiana.⁷⁶

Presenting symptoms may be useful in determining appropriate treatment interventions.⁸⁰ Isolated fang marks can indicate the presence of a venomous bite with a demonstrated sensitivity of 100% and positive predictive value of 89%. The presence of multiple scratches, on the other hand, has demonstrated a positive predictive value of 100% for nonvenomous bites.⁸⁰ Symptoms largely include pain and swelling with accompanying erythema, ecchymosis, and paresthesia. Additional symptoms are described in Table 4.^{68,75,81}

Antivenom such as CroFab, which has been recognized as the first line over antivenin crotalidae polyadvent, is successful in the treatment of most bites.^{75,82,83} Additional protocol features should include removal of articles that may constrict limb swelling, maintenance of patent airway, and immobilization of bitten limb at a level below the heart to prevent systemic spread.^{82,84} Lack of education regarding proper snake bite management poses barriers to appropriate treatment administration and results in increased complication rates.^{85–87} Antivenom administration has

Table 3. Common Pathogens and Subsequent Treatment of Cat Bites

Pathogen	Recommended Treatment	Timing	Route of Administration	Dosage	Notes
<i>Pasteurella multocida</i>	Beta-lactam ⁴⁴ (eg, penicillin) Beta-lactamase inhibitors ⁴⁴ (eg, tazobactam) Aggressive broad-spectrum antibiotics	2 to 3 times a day with accompanying meal	Typically oral administration	25–50 mg for children; 250–300 mg for adults	Aggressive broad-spectrum antibiotics used only if infection is advanced
<i>Staphylococci</i> ⁶¹	Beta-lactam ⁴⁴ (eg, penicillin) Beta-lactamase inhibitors ⁴⁴ (eg, tazobactam)	2 to 3 times a day with accompanying meal	Typically oral administration	25–50 mg for children; 250–300 mg for adults	
<i>Francisella tularensis</i> ⁶²	Streptomycin	2 daily doses; one dose every 12 h	Typically IM	30–40 mg/kg/d for children; 7.5–10 mg/kg/d for adults	
<i>Yersinia pestis</i> ⁶³	Streptomycin Gentamicin	2 daily doses; one dose every 12 h	IM	30 mg/kg/d for children; 2 g/d for adults	
<i>Sporothrix schenckii</i> ⁶⁴	Itraconazole	3 to 6 mo antibiotic treatment; 1 dose daily; 2 doses if patient is unresponsive	Oral administration	200 mg	Should not be administered to pregnant patients
<i>Bartonella henselae</i> ⁶⁵	Azithromycin	1 d of a certain dosage and 4 d of a lesser dosage	Oral administration	10 mg/kg/d 1 followed by 5 mg/kg for four more days for children; 500 mg/d 1 followed by 250 mg for 4 d for adults	It should be noted that some infections do not require antibiotics, especially if it is a localized lymphadenopathy

IM, intramuscular.

been reported with the rare occurrence of an immediate or delayed onset hypersensitivity reaction.⁸⁸

A wide array of complications may ensue, including systemic, pulmonary, neurological, renal, and local wound manifestation.^{75,81,89–91} These symptoms commonly include hemorrhagic blisters, pulmonary edema, compartment syndrome, cranial nerve paralysis, stroke, and shock.^{75,79,92} Sequelae including respiratory failure, dyspnea, systemic bleeding, sepsis, and shock have been documented as strongly associated with fatal outcomes.⁸⁷ Common pathogens and treatments are presented in [Table 5](#).

Rodents

An estimated 20,000 rat bites occur in the United States annually.⁹⁴ Those most affected are children under 5 years old.^{94,95} Biting incidents often occur in the home, during summer months and between the hours of midnight and 8 AM.⁹⁵ Clinical presentation is often on the face

and hands.⁹⁵ Common pathogens and treatments are presented in [Table 6](#).

Horses

Although horse-related fatalities are more common, horse bites are rarely reported,¹⁰¹ with incidence varying by country. For example, horse bites have been reported to account for 17% of all bites in Turkey, doubling that of cat bites.⁴⁶ Clinically, these injuries often present as tissue loss to the head and neck areas, followed by injury to the extremities and least often the trunk.¹⁰¹ Treatment should include cleaning with saline, rather than irrigation with antibiotic or iodine solution, in an effort to decrease potential tissue irritation.^{19,101} Following debridement, primary closure and surgical intervention are both potential treatment options, but primary closure is advised.¹⁰¹ Subsequent infection is rare, but has been reported in conjunction with osteomyelitis, and few complications have been described on follow-up to initial treatment.^{94,101} Common pathogens and treatments are presented in [Table 7](#).

Sharks

Since the 1990s, there have been 5034 shark attacks reported worldwide and 1205 of these incidents were fatal (22.7%).¹⁰⁷ Most incidents occurred in North America (36.7%) and Australia (26.5%).¹⁰⁷ Commonly affected populations include males, Whites, and those of middle age.¹⁰⁸ Presentation often involves the legs (41.8%) and arms (18.4%), with limb loss documented in 7% of attacks.¹⁰⁷ However, most patients sustain only minor

Table 4. Symptoms Associated with Snake Bites

Additional Symptoms	Occurrence (%)
Hemotoxicity	76.9
Local Reaction	9.6
Syncope	9
Neurotoxicity	4.5
Ptosis	4.5
Altered sensorium	4.5
Breathlessness	3.2
Diplopia	2
Oliguria	1.3
Dysarthria	0.6
Chest pain	0.6

Table 5. Common Pathogens and Subsequent Treatment of Snake Bites

Pathogen	Recommended Treatment	Timing	Route of Administration	Dosage	Notes
Snake venom	Antivenom such as CroFab ACP	Must be applied as quickly as possible	Intravenous injection	Dosage reports have shown to not cause significant change. Quick administration is more important	Antivenom has been shown to be more effective
Gram negative Enterobacteriaceae and Enterococci ⁹³	Ciprofloxacin	2 doses daily; 1 dose every 12 h	Typically oral	250–750 mg	Enterobacteriaceae and Enterococci are very resistant to typical beta-lactam and beta-lactamase inhibitors which is why ciprofloxacin is used

ACP, antivenin crotalidae polyadvent.

injuries that can be primarily repaired.¹⁰⁹ Limb losses greater than 20 cm and soft-tissue lacerations to more than one myofascial compartment are associated with higher morbidity.¹⁰⁹ Treatment for these injuries follows the principles of debridement and reconstruction.^{110–112}

Alligators and Crocodiles

From 1928 until 2009, 567 reports of alligator attacks have been documented in the United States, with 24 resulting in death.¹¹³ The population most affected are those of middle age, with a median of 31.8 years, for both Australian and American alligator attacks.¹¹⁴ Most injuries reported have occurred while swimming or wading in shallow water at night.¹¹⁵ They commonly present as a result

of penetrating, blunt and shear forces, ranging from minor scratches and punctures to amputations and death, with deep punctures being the initial and most common presentation.^{114,115} The severity of presentation is often linked to alligator size.¹¹⁵ Injury is often to the extremities, accounting for 80% of the largest series of Nile crocodile reports and 88% in the largest series of alligator injury reports.¹¹⁴

Initial treatment often includes extensive surgical cleaning and debridement,^{111,112} obtaining wound cultures, and administration of antitetanus treatment and broad-spectrum antibiotics.^{115,116} Significant hemorrhage should be controlled with direct pressure and wound packing.¹¹⁴ Radiographs should be obtained in the case

Table 6. Common Pathogens and Subsequent Treatment of Rodent Bites

Pathogen	Recommended Treatment	Timing	Route of Administration	Dosage	Notes
<i>Pasteurella multocida</i>	Beta lactam ⁴⁴ (eg, penicillin) Beta lactamase inhibitors ⁴⁴ (eg, tazobactam) Aggressive broad-spectrum antibiotics	2 to 3 times a day with accompanying meal	Typically oral administration	25–50 mg for children; 250–300 mg for adults	Aggressive broad-spectrum antibiotics used only if infection is advanced
<i>Bacillus subtilis</i> ⁹⁶	Clindamycin ⁹⁷	3 to 4 times a day ⁹⁸	Liquid capsule; oral with water	8–12, 13–16, or 17–25 mg for children depending on the severity of the infection; 150–300 or 300–450 mg for more advanced infections for adults ⁹⁸	This organism has demonstrated significant sensitivity and resistance to many beta-lactams, thus they are to be avoided
Alpha-Hemolytic Streptococcus	Vancomycin ⁹⁹ Beta-lactam ⁴⁴ (eg, penicillin) Vancomycin ⁹⁹	2 times a day; 1 dose every 12 h 2 to 3 times a day with accompanying meal 2 times a day; 1 dose every 12h ⁹⁹	IV injection Typically oral administration IV injection	15 mg/kg 25–50 mg for children; 250–300 mg for adults 15 mg/kg	There has been data showing growing resistance to beta-lactam antibiotics. Vancomycin is typically used if patient is unresponsive to beta-lactams or if infection is advanced ^{44,99}
<i>Francisella tularensis</i> ⁶²	Streptomycin	2 daily doses; one dose every 12 h	Typically IM	30–40 mg/kg/d for children; 7.5–10 mg/kg/d for adults	Growing resistance to Penicillin G but not enough to justify treatment change, streptomycin and tetracycline also appear to be effective treatments
Rat bite fever: <i>Streptobacillus moniliformis</i> ¹⁰⁰	Penicillin G	Children: 7 d of IV followed by 7 d of oral Adults: 7 d of IV	IV and/or oral	12–30 mg/kg/d for children + 25–50 mg/kg/d; 240–36 mg for adults with no oral addition	
Rat bite fever: <i>Spirillum minus</i> ¹⁰⁰	Penicillin G	Children: 7 d of IV followed by 7 d of Oral Adults: 7 days of IV	IV and/or oral	12–30 mg/kg/d for children + 25–50 mg/kg/d; 240–36 mg for adults with no oral addition	

IM, intramuscular; IV, intravenous.

Table 7. Common Pathogens and Subsequent Treatment of Alligator and Crocodile Bites

Pathogen	Recommended Treatment	Timing	Route of Administration	Dosage	Notes
<i>Pseudomonas aeruginosa</i> ^{102,103}	Piperacillin + tazobactam ^{102,103} Ciprofloxacin ¹⁰⁴	<i>Piperacillin + tazobactam</i> : 30-min injection periods every 6 h for mild infections, 6–8 h for severe infections <i>Ciprofloxacin</i> : 30-min injection periods every 8 h ¹⁰⁴	IV	<i>Piperacillin + tazobactam</i> : Mild: 3.375 g Severe: 4.5 g <i>Ciprofloxacin</i> : 400 mg	This bacteria has been shown to have increased resistance to many treatments such as the most common: ciprofloxacin. Studies have indicated debate on the appropriate treatment, but current consensus is beta-lactam treatment at the minimum and aminoglycoside can be additionally added, though with more side effects ^{102,104}
<i>Aeromonas hydrophilia</i> ¹⁰⁵	Doxycycline ¹⁰⁶	100 mg every 12 h for the first day followed by 50 mg every 12 h	Oral	200 mg for the first day followed by 100 mg for the following days	Avoid ampicillin and first generation cephalosporins. Also, it may be recommended to take either ciprofloxacin or ceftriaxone in combination with doxycycline though studies have shown no difference between the monotherapy and the combination ^{105,106}

IM, intramuscular; IV, intravenous.

Table 8. Common Pathogens and Subsequent Treatment of Horse Bites

Pathogen	Recommended Treatment	Timing	Route of Administration	Dosage	Notes
<i>Actinobacillus ligniserezii</i> ^{118,119}	Combination of tetracycline or streptomycin and potassium iodide	3 wk administration of both potassium iodide and tetracycline/streptomycin <i>Potassium iodide</i> : daily <i>Streptomycin</i> : 2 daily doses; one dose every 12 h ¹¹⁸	Oral or IV for potassium iodide + IM for streptomycin	<i>Potassium iodide</i> : 6–10 g oral or 8 g/kg IV + <i>streptomycin</i> : 30 mg/kg/d for children; 2 g/d for adults ¹¹⁹	This organism is extremely rare in humans
<i>Streptococcus anginosus</i> ¹²⁰	Vancomycin	2 times a day; 1 dose every 12 h	IV injection	15 mg/kg	Penicillin and clindamycin have begun to show resistance
<i>Streptococcus mutans</i> ¹²¹	Ampicillin ¹²²	Every 6 h	Oral	50–100 mg/kg/d for children; 250–500 mg for adults	Various drugs could work such as cefotaxime, but ampicillin has shown best results. Intravenous and intramuscular injection is also possible
<i>Campylobacter ureolyticus</i> ^{123,124}	Azithromycin ¹²³	Daily for 3–10 d as necessary	Typically oral	500 mg	<i>Campylobacter</i> has shown fluoroquinolone resistance in some populations. Contraindicated if patient presents with liver or kidney issues ¹²⁴
<i>Prevotella melaninogenica</i> ¹²⁵	Metronidazole ¹²⁶ Beta-lactam ⁴⁴ (eg, penicillin) + beta-lactamase inhibitors ⁴⁴ (eg, tazobactam)	Every 6 h for 7–10 d as necessary	Typically oral	7.5 mg/kg	There are many combinations that are possible to treat this bacteria
<i>Bacteroides fragilis</i> ²⁷	Metronidazole ¹²⁶	Every 6 h for 7–10 d as necessary	Typically oral	7.5 mg/kg	This bacterial is resistant to penicillin. Although there have been increasing reports of resistance to metronidazole, it is still the favored treatment
<i>Pasteurella caballi</i> ²⁸	Ampicillin ¹²²	Every 6 h	Oral	50–100 mg/kg/d for children; 250–500 mg for adults	There are many possible drug options but has shown the least amount of resistance
<i>Yersinia pestis</i> ⁶³	Streptomycin Gentamicin	2 daily doses; one dose every 12 h	IM	30 mg/kg/d for children; 2 g/d for adults	

IM, intramuscular; IV, intravenous.

of suspect bone fracture or retained foreign bodies.^{114,117} Devitalized tissue should be debrided and the remaining wound site should be left to heal by secondary intention or delayed primary closure.^{115,117} Most complications are related to serious deformities, reported in 40% of patients, but necrotizing soft-tissue infections and death have also been cited.^{115–117} Common pathogens and treatments are presented in Table 8.

Spiders

Although there are no definitive data on the occurrence of spider bites, many that can cause medically relevant harm to humans are rare and typically secluded to certain regions in Australia, except for the widow spider (*Latrodectus*), which has over 30 species.^{129,130} The venom produced by these spiders has been shown to cause long-lasting systemic and regional pain, patchy paralysis, agitation, hypertension, among other symptoms.¹³¹ Treatment historically consisted of calcium derivatives geared to relax muscle, which have since shown to be ineffective.^{132,133} A combination of antibody-derived antivenom is now the preferred treatment, although one major study showed a significant reduction in pain for 48 hours using antivenom,¹³³ whereas another major study showed no improvement in pain.¹³⁴ Moreover, there seems to be no difference between administering the antivenom intravenously (IV) or intramuscularly (IM),¹³² but the literature is sparse. More data are needed to reach a formal conclusion regarding antivenom efficacy. Also, antivenom is expensive and harder to attain so it may not be accessible in resource-limited settings. Analgesics are typically used and have demonstrated effectiveness toward limiting pain and should be the primary method of treatment.

DISCUSSION

Animal bites are a common cause of medical visits worldwide; familiarity with the clinical presentations and complications of animal bites allows the clinician to better treat these bites. The presentation of injuries is broad, and the appropriate treatment is predicated on both the characteristics of the inciting animal and the patient. Most animal bites can be treated with supportive care, though some require more invasive surgical debridement and reconstruction. This article synthesizes pertinent information regarding the incidence, common presentation, initial treatment, and potential complications associated with dogs, cats, horses, rodents, snakes, marine life, and spider bites.

It cannot be ignored that many of the suggested treatments and protocols are not as easily administered in low- and middle-income countries and resource-limited settings. The issues mainly stem from limitations of ideal and proper treatment due to cost, distribution, and awareness of specific treatment modalities.^{29–34,135} Although efforts should be made to increase the availability of novel treatments and patient education, utilization of basic supportive care can be implemented and is a powerful tool in resource-limited settings. Initial irrigation,¹⁹ debridement, and wound culture are often inexpensive and are

a common indication in the management of many bites. Irrigating the wound with saline is an effective and readily accessible initial treatment for bite wounds.¹³⁶ This should be followed by clinical assessment of the wound to determine the depth and extent of the wound; radiology studies may be required if there is clinical concern for fractures.¹³⁶ Common antibiotics are indicated for many of the most common pathogens found in bite wounds; this may be directed by culture data as available. For rarer bites such as snake bites, if antivenom is not available, removing jewelry, placing the patient in the recovery position, and applying a pressure immobilization bandage are all inexpensive treatment methods.^{137,138} Supportive treatment options should be prioritized for animal bites as these are cost-effective and can be provided in resource-limited settings.

This review article is limited due to the few high-quality studies published on animal bites. This especially applies to more rare animal bites such as spider bites. In the studies identified, sample sizes are generally small, limiting generalizability. An additional limitation is the non-English language exclusion criteria, which restricts our analysis to a largely high-income country population, limiting generalizability to resource-limited settings.

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