Human and Animal Bites

Fernando J. Bula-Rudas, MD,* Jessica L. Olcott, MD†

*Department of Pediatrics, Division of Pediatric Infectious Diseases, Sanford Children's Hospital, Sioux Falls, SD
†Department of Pediatrics, Sanford Children's Hospital, Sioux Falls, SD

Practice Gaps

1. To provide appropriate care to children who have sustained human or animal bites, health practitioners should be able to manage bite wounds to minimize the risk of the child developing serious or even fatal infections.
2. Clinicians should be able to implement strategies for providing anticipatory guidance regarding pet ownership and animal contact outside the household as part of the health supervision visit.

Objectives After completing this article, readers should be able to:

1. Understand the epidemiology of human and animal bites in children.
2. Identify common etiologic pathogens associated with human and animal bite wound infections.
3. Apply strategies oriented to prevent the development of bite wound infections and to decrease the risk of fatal infections such as rabies or tetanus.
4. Manage bite wounds adequately to decrease morbidity and mortality associated with these.
5. Develop strategies for providing education and anticipatory guidance to children and their caregivers regarding safety with pets and animal contact.

Abstract

In the United States, nearly 56% of households owned a pet in 2011 according to the *2012 U.S. Pet Ownership & Demographics Sourcebook* by the American Veterinary Medical Association. The survey also reports that approximately 70 million dogs and 74 million cats lived in households in the United States during the same year. (1)

Human and animal bites are a frequent cause of primary care and emergency department visits for children. It is estimated that 250,000 human bites, 400,000 cat bites, and 4.5 million dog bites occur in the United States each year in both adults and children. (2) In the United

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ABBREVIATIONS

AAP	American Academy of Pediatrics
CDC	Centers for Disease Control and Prevention
MRSA	methicillin-resistant *Staphylococcus aureus*
spp.	species

States, approximately 10% of all human bites will become infected in a child with a bite wound. The infection rate of dog bites in children is 20%. Cat bite infection rates in children vary but can be up to 50%. Each type of bite wound has a predisposition for sex and/or age. Infected bite wounds manifest with swelling, erythema, and tenderness with or without drainage of the affected site and can lead to serious complications. Most animal bite wounds are polymicrobial in nature. *Pasteurella* species (spp.) is the most common organism isolated from both cat and dog bites. The microbiology of human bites consists of both aerobic and anaerobic bacteria.

Basic medical management of bite wounds includes thorough cleansing and debridement. Irrigation, closure, and need to obtain culture depend on the type of bite wound, the appearance of the wound, the and timing of medical evaluation after the initial injury. Amoxicillin-clavulanate is the antibiotic of choice for prophylaxis and empirical therapy for children who are not allergic to penicillin. With most animal bites being preventable injuries, healthcare providers caring for children have an important role discussing pet safety with the child and the family.

INTRODUCTION

Human and animal bites are a frequent cause of primary care and emergency department visits for children. Historically, the morbidity of such injuries was quite significant, with 1 study reporting one-third of patients requiring amputation if care was sought more than 24 hours after initial injury. However, the morbidity has greatly decreased because of a better understanding of the epidemiology and microbiology of such injuries, leading to the development of clinical practice guidelines and targeted antibiotic drug therapy.

EPIDEMIOLOGY

It is estimated that 250,000 human bites, 400,000 cat bites, and 4.5 million dog bites occur each year in the United States in adults and children. Children are more likely than adults to sustain animal bites. Although only 10% of all bite wounds occur to the face, two-thirds of those wounds occur in children younger than 10 years of age. (2) Wounds in the extremities account for at least three-quarters of all bites, with the hand being the most common site. Wounds to the hand are most likely to become infected, and wounds to the face are least likely to become infected. In addition, puncture wounds are more likely to become infected than superficial wounds, lacerations, or wounds with obvious skin and soft tissue defects.

Cat bites are more evenly distributed among age groups, without a predisposition for one group in particular. Females are more likely to sustain cat bites than males. Injuries caused by cat bites seem to be less severe than most human or dog bites on first glance due to less skin and soft tissue destruction. Nonetheless, cat bites are more likely to have serious sequelae because they are small, deep puncture wounds that are difficult to cleanse. The infection rate for cat bites in the United States varies but can be up to 50%. (3)

The incidence of dog bites in children in developed countries is 1 to 3 per 1,000 children per year, which equates to nearly one-half to three-fourths of all dog bites of all ages. Males are twice as likely as females to sustain a dog bite injury. An average of 20 deaths associated with dog attacks are reported yearly in the United States. Sepsis and intracranial infections are the most common causes related to these deaths. Overall, approximately 20% of all dog bite wounds in US children become infected. (4)

The peak incidence of sustaining a dog bite occurs in the 5- to 9-year-old age group. (5) Preschool children are more likely to sustain bite injuries to their head and face, likely because their head is at mouth level of medium- and large-sized dogs. Nevertheless, children younger than 5 years of age are more likely to have attacks and injuries from smaller dogs. As a child gets older, injuries to the extremities become more common. In general, the child knows the owner of the dog in more than 75% of all bite wound cases. (2)

Bites from crossbred dogs account for most injuries because of their popularity among dog owners. However, a child's relative risk of injury is highest when interacting with German shepherd, pit bull, rottweiler, and Doberman breeds due to the sheer force that these dogs exert when biting. One study showed that the relative risk of an attack by a Doberman or German shepherd was approximately 5 times that of a Labrador retriever or crossbred species. (6) Another study evaluating 551 pediatric dog bite injuries in the United States found that pit bull terriers caused 51% of the injuries. Rottweiler was the second most common breed implicated in bite wounds at 9%. (7)

Paronychia is not considered specifically a bite wound because the mechanism of injury is different. This can occur when a child bites his or her own finger, but often it is secondary to a child obsessively sucking on his or her finger(s). Presence of a hangnail predisposes to paronychia. Because paronychia is caused by oral flora, it may be treated in a similar manner as human bite wounds.

Animal bites are a significant risk of transmission for rabies. In 2015, the 50 US states and Puerto Rico reported to the Centers for Disease Control and Prevention (CDC) 5,508 cases of animal rabies and 3 human cases. There are no documented cases of rabies in Hawaii. More than 90% of animal cases of rabies in the United States occur in wildlife, with bats being the animals with the highest percentage of cases (30.9%), followed by raccoons (29.4%), skunks (24.8%), and foxes (5.9%). Domestic animals accounted for only 7.6% of the cases. (8) Small rodents (rats, mice, squirrels, and hamsters) and lagomorphs (hares, pikas, and rabbits) rarely transmit rabies. Large rodents may pose a risk of transmission in areas where raccoon rabies is common.

Humans are incidental reservoirs of rabies, which is mainly an infection of other animals. In the United States, the number of human deaths caused by rabies has declined from 100 or more per year to 1 or 2 per year since the 1990s. This reduction in deaths happened mainly because of successful prophylaxis in domestic animals, especially among dogs, which are practically no longer a reservoir for rabies in the United States. According to data from the CDC, there were 23 cases of human rabies in the US states and Puerto Rico from January 2008 to September 2017. Eleven of these cases were indigenous, and the transmission was associated with bat exposure. There were 3 pediatric cases documented in this period: an 8-year-old who survived and had an unknown exposure; a 17-year-old who survived and had a bat exposure; and a 16-year-old who died and had a fox bite in Mexico. (8)

In contrast to the United States, exposure to rabid dogs accounts for more than 90% of human exposure and approximately 99% of human deaths caused by rabies worldwide. (8) Developing countries may have limited resources for reporting of rabies infections along with lack of public health programs directed to vaccination of stray dogs. Limited access to health-care and unavailability of rabies vaccine and immunoglobulin are significant factors that may contribute to such a high index of mortality.

Tetanus is another infection potentially caused by an animal or human bite. *Clostridium tetani* is ubiquitous in the environment and is commonly present in soil and both human and animal intestines. When present in a wound, the organism may replicate and produce toxins that are responsible for the characteristic tetanus infection. Cases of tetanus are significantly rare in the United States because of widespread routine immunization against it. In the United States there are reports of sporadic cases, and these occur mainly in adults with lack of immunization during childhood or inadequate boosters later in life. (9)

MICROBIOLOGY

Wound infections caused after any type of bite are usually polymicrobial in nature. Mixed aerobic and anaerobic bacteria from the mouth flora of the biting animal and the flora of the victim are commonly isolated in bite wound infections. An average of 5 different bacterial isolates per culture were reported in a series of infected wounds caused by dog and cat bites. (10)

Pasteurella spp. were the most frequent pathogens isolated in both types of animal bites (50% in dogs and 75% in cats). *Pasteurella* are facultative anaerobic gram-negative coccobacilli that grow on blood or chocolate agar. They are usual colonizers of the upper respiratory tract of many animal species. Dogs, cats, and other mammalians have high carriage rates of *Pasteurella* spp. in their oropharynx; therefore, a significant number of infections are caused by these microorganisms (Table 1). *Pasteurella canis* is the most common bacteria isolated in dog bites and *Pasteurella multocida* subspecies *multocida* in cat bites. (10)

Capnocytophaga canimorsus was identified as a pathogen causing severe infections in a series of 39 cases of bite wound infections. Dog bites caused infection in 56% of the cases from the same series, and 10% were associated with licking from the animal. Infections by *Capnocytophaga* pose a significant risk for sepsis in asplenic and immunocompromised children. (11)

Fusobacterium, Bacteroides, Prevotella, Propionibacterium, and *Peptostreptococcus* are other anaerobic bacteria recognized in isolates from bite wound cultures. *Eikenella corrodens* and *Streptococcus pyogenes* are more frequently associated with

TABLE 1. **Important Pathogenic Bacteria in Bite Wounds**

TYPE OF BITE	TYPE OF BACTERIA: AEROBES	TYPE OF BACTERIA: ANAEROBES
Dog	*Pasteurella* spp. *Streptococcus* spp. *Staphylococcus* spp. *Capnocytophaga canimorsus*	*Fusobacterium* spp. *Bacteroides* spp. *Prevotella* spp. *Porphyromonas* spp. *Propionobacterium* spp. *Peptostreptococcus* spp.
Cat	*Pasteurella* spp. *Streptococcus* spp. *Staphylococcus* spp. *Moraxella* spp.	*Fusobacterium* spp. *Bacteroides* spp. *Porphyromonas* spp. *Prevotella* spp. *Propionobacterium* spp.
Human	*Streptococcus* spp. *Staphylococcus* spp. *Eikenella corrodens* *Haemophilus* spp.	*Fusobacterium* spp. *Prevotella* spp. *Peptostreptococcus* spp. *Veillonella* spp.

human bites. *Streptococcus pyogenes* was identified in cultures from dog bites but in none of the cultures from cat bites. Streptococci, *Staphylococcus aureus, Moraxella catharralis, Neisseria* spp., and *Corynebacterium* are other common aerobic bacteria found in infected dog and cat bites. *Staphylococcus aureus* causes infection more frequently in dog bites than in cat bites. (11)

Cultures from human bites are usually mixed with aerobic and anaerobic bacteria. *Streptococcus anginosus, Streptococcus pyogenes, S aureus, E corrodens,* and *Haemophilus* spp. are aerobic bacteria commonly isolated from human bites. *Eikenella corrodens* is a gram-negative rod frequently associated with wound infections caused by clenched-fist injuries. This pathogen is susceptible to penicillin but exhibits resistance to first-generation cephalosporins and β-lactamase–stable penicillins. *Prevotella* spp., *Peptostreptococcus* spp., *Fusobacterium* spp., *Bacteroides* spp., and *Veillonella* spp. are anaerobic bacteria frequently isolated in wounds from human bites. (12)

More severe infections and greater morbidity are associated with anaerobic bacteria cultured from wounds sustained by human bites compared with animal bites. Most of these anaerobes are β-lactamase producers, thus the importance of choosing adequate empirical antibiotic coverage with a β-lactamase inhibitor. Cultures from paronychia report similar microbiologic pathogens as wounds caused by human bites, although the mechanism of injury is different, as described previously.

Etiologic agents from bites of species other than dogs, cats, and humans, are not well described in the medical literature. Infections with *Pasteurella* spp. have been described in bites by large felines such as tigers and leopards. *Pseudomonas* spp., *Aeromonas hydrophila,* and *Clostridium* spp. have been isolated in infections from catfish, eel, and reptiles. (12)

Both human and animal bites have the potential to transmit pathogens that cause systemic infections. Tetanus, rabies, *Bartonella* (cat-scratch disease), tularemia, brucellosis, leptospirosis, and rat-bite fever may be transmitted through an animal bite. Insects such as ticks, flies, and mosquitoes have the potential to carry and transmit significant viral, bacterial, fungal, and parasitic sources of infection. Human bites may transmit important pathogens, such as hepatitis B and C virus, cytomegalovirus, and herpesvirus. Transmission of human immunodeficiency virus through human bites is extremely rare; however, it is biologically possible, and a few cases have been reported (Table 2). (13)

CLINICAL MANIFESTATIONS

Patients who experience an animal bite wound can show signs and symptoms of infection within hours to days after the initial injury. Manifestations suggestive of infection include pain, erythema, and swelling of the affected area. Serosanguineous or purulent drainage may or may not be present. Most individuals are afebrile at the time of evaluation. Lymphadenitis or lymphangitis is present in 20% of patients or less.

Patients infected with *P multocida* secondary to an animal bite tend to experience intense pain, swelling, and erythema within 12 to 18 hours of sustaining an injury. (14) In comparison, patients with a staphylococcal or streptococcal infection tend to develop less intense symptoms over days

TABLE 2. **Other Systemic Infections Transmitted by Human and Animal Bites**

ANIMAL TYPE	INFECTIONS
Dog	Leptospirosis (*Leptospira* spp.) Tetanus (*Clostridium tetani*) Tularemia (*Francisella tularensis*) Rabies (rabies virus)
Cat	Cat-scratch disease (*Bartonella* spp.) Tularemia (*F tularensis*) Sporotrichosis (*Sporothrix* spp.) Rabies (rabies virus)
Human	Hepatitis B (hepatitis B virus) Hepatitis C (hepatitis C virus) Cytomegalovirus infection Herpes (herpes simplex virus) Syphilis (*Treponema pallidum*) Human immunodeficiency virus infection
Rat	Rat-bite fever (*Streptobacillus moniliformis* or *Spirillium minus*) Leptospirosis (*Leptospira* spp.)
Rodents	Leptospirosis (*Leptospira* spp.) Tularemia (*F tularensis*)
Bat Ferret Raccoon Fox	Rabies (rabies virus)

rather than hours. In addition, the cellulitis caused by staphylococci or streptococci is more diffuse and typically less severe than that seen with *P multocida* infections.

Complications of animal bites other than cellulitis must be kept in mind when evaluating human and animal bites. Osteomyelitis, tenosynovitis, tendinitis, orbital cellulitis, or brain abscesses can occur. Signs and symptoms of osteomyelitis include persistent pain, swelling, and erythema of the infected site in addition to tenderness to palpation of a bony structure near the bite site. Tenosynovitis also involves persistent pain, swelling, and erythema of the infected site in addition to tenderness to palpation of a bony structure near the bite site. Tenosynovitis also involves persistent pain, swelling, and erythema but instead of bony tenderness there is often a mass overlying an infected tendon sheath. Brain abscesses and meningitis should be kept in mind when evaluating children with perforating cranial bites because these can prove to be fatal complications.

Of all human bites, clenched-fist injuries are the most serious because they can lead to severe sequelae. These injuries are sustained when one person uses a closed fist to strike another person in the teeth, leading to a break in the skin over the knuckles. The injury most commonly affects the metacarpophalangeal joint of the third digit of the dominant hand. (13) The seriousness of clenched-fist injuries is often overlooked because the initial injury typically does not appear significant. Bacteria that entered through the broken skin over the knuckle can be carried to the tendons proximally as a person relaxes the hand from a closed to an open position. This potentiates the spread of bacteria to the deeper surfaces of the hand. In addition, the joint capsule or bone is frequently involved with this type of injury. Given these features, patients with clenched-fist injuries are at high risk for septic arthritis, osteomyelitis, tenosynovitis, tendinitis, joint stiffness, or permanent limited range of motion, prompting the need for immediate antibiotic drug treatment. Patients with clenched-fist injuries usually seek medical care due to signs and symptoms of infection within 8 hours of sustaining the injury.

Patients with infected human bites, including clenched-fist injuries, present with similar manifestations as infected animal bites, including pain, tenderness, and erythema of the affected site with or without serosanguineous or purulent drainage. Paronychia presents with the same symptoms as any bite wound infection of the hand. Fever, lymphadenitis, and lymphangitis are rarely present. Infection of the hand typically spreads proximally up the arm, as opposed to distally. Complications of non–clenched-fist injuries include compartment syndrome and nerve injury, in addition to osteomyelitis, septic arthritis, tenosynovitis, and tendinitis. However, these complications are seen less commonly than with clenched-fist injuries.

MANAGEMENT

Management of human and animal bites should include measures to provide appropriate care of the wound in the immediate period of the injury and adequate actions targeted to identify and minimize the risk of infections or other serious complications. We propose the following stepwise approach based on our review of the literature (Table 3):

1. History. Obtain a pertinent clinical history to help with the decision-making process for actions regarding initial wound care, including the need for active or passive immunizations, indications for obtaining cultures that would help determine specific pathogens, indications for antibiotic prophylaxis versus empirical therapy, and establishment of an adequate disposition for the patient.
2. Evaluation. Perform an initial assessment of the patient with particular emphasis on the clinical status of the child and the location, extension, characteristics, and severity of the wound. Obtain appropriate imaging tests to visualize structures that are at risk for being affected.

3. Wound management. Practice adequate cleansing of the wound and identify indications for immediate closure versus delayed closure and watchful monitoring. Obtain cultures if indicated.
4. Medications. Follow indications for active and/or passive immunizations based on the child's history. Choose appropriate antibiotics for empirical coverage when indicated for prophylaxis or for treatment of infection (Tables 3 through 5, Fig).
5. Disposition. Establish appropriate disposition for the child. Determine whether the child requires hospital admission or management as an outpatient with adequate follow-up.

ANTIMICROBIAL THERAPY

There are limited data about specific recommendations for antibiotic prophylaxis for animal bites. However, the Infectious Diseases Society of America guidelines state that for soft tissue and skin infection it is recommended to prescribe preemptive antibiotic agents for patients who are immunocompromised and those who are asplenic; for patients with advanced liver disease; for patients with moderate to severe puncture wounds, especially injuries that may have penetrated the bone, tendon, or joint capsule; and for facial, hand, foot, or genitalia bites. Duration of preemptive therapy may be up to 3 to 5 days, but all children with bite wounds need to be reevaluated within 24 to 48 hours to monitor for signs and symptoms of infection. (15) For soft tissue infection, a 7- to 10-day course of antibiotic therapy may be sufficient. However, the final duration of therapy depends on the location and severity of the wound and the patient's clinical response. A 10- to 14-day course of antibiotics is indicated for more severe infections and should be extended for 4 to 6 weeks in the presence of bone and joint infections. (15)

Optimal selection of empirical antibiotic agents should be based on the most common pathogens according to the type of bite (eg, animal or human), the location of the wound (eg, hand, face, skull), and the possible patterns of resistance expressed by the bacteria. In general, an adequate antibiotic regimen should provide coverage for the potential pathogenic aerobic and anaerobic flora from the mouth of the animal or human inflicting the bite. Some experts recommend antibiotic prophylaxis in mild dog bites managed in a medical facility 8 hours after the event and for all moderate to severe dog bites seen less than 8 hours after the event with particular attention to the presence of edema or signs of crush injury. (16)

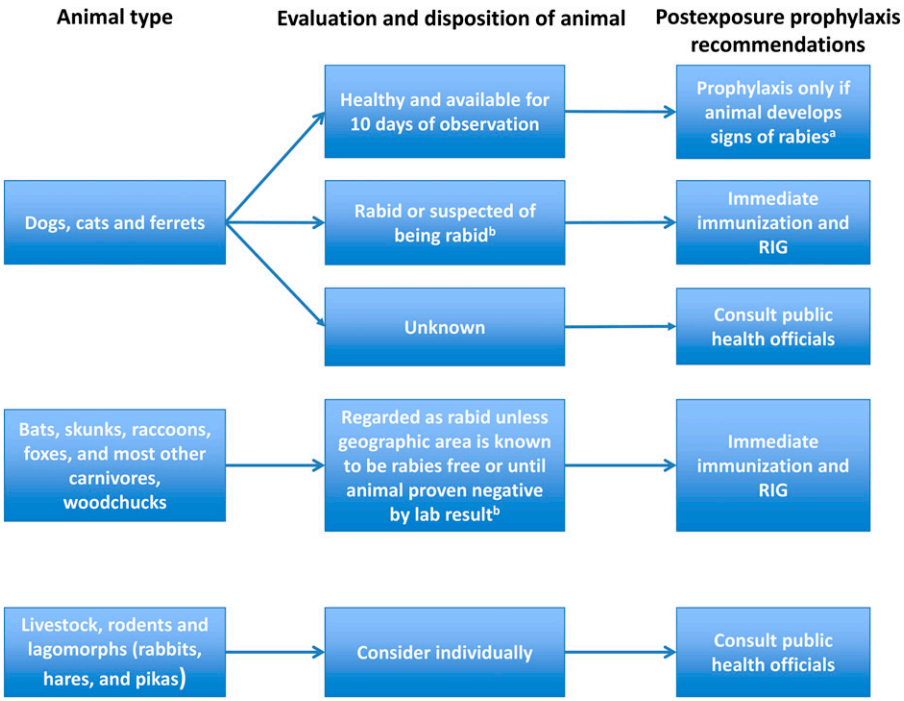


Figure. Rabies postexposure prophylaxis. [a]Prophylaxis of the exposed child should be started with rabies immune globulin (RIG) and vaccine at the first sign of rabies in the biting animal. [b]The animal should be euthanized and tested as soon as possible. Observation is not recommended for these types of animals. Immunization is discontinued if there are negative immunofluorescent test results from the animal. (Adapted with permission from American Academy of Pediatrics. Rabies. In: Kimberlin DW, Brady MT, Jackson MA, Long SS, eds. *Red Book: 2015 Report of the Committee on Infectious Diseases*. 30th ed. Elk Grove Village, IL: American Academy of Pediatrics; 2015:658–666.)

TABLE 3. **General Management of Bite Wounds**

MEASURE	ACTION
History	Animal • Type of animal • Health of the animal • Attack provoked versus unprovoked • Human bite (health status of the person inflicting the bite [HIV, HBV, HCV]) Patient • High-risk patient? Immunocompromised, asplenic • Immunization status of the patient (tetanus, HBV)
Evaluation	• Vital signs and clinical assessment • Location and depth of the wound • Type of wound (puncture, abrasion, avulsion, laceration) • Extent of the wound, edema, erythema, foreign material present, purulent discharge • Neurovascular examination
Initial management	• Hibiclens or povidone-iodine should not be used • Do not irrigate puncture wounds • Irrigate wounds other than puncture using splashguard shields with ≥250 mL of normal saline. If not available use an 18-gauge catheter or needle attached to a 30- or 60-mL syringe • Based on clinical suspicion may obtain pertinent diagnostic imaging to rule out foreign material • Perform debridement and removal of foreign material • Obtain wound cultures if evaluation occurs >8 h after the event or if the wound has signs of infection
Wound closure	• Early primary closure for wounds of the face and neck • Primary closure of wounds from animal bites may be appropriate if none of the following are met: ✓ Wounds in the hand should be left open. Consider consultation with a hand surgeon. Clenched-fist injury should be evaluated by a surgeon ✓ Wounds with signs of infections should not be closed ✓ Closure is not recommended in high-risk wounds if >8 to 12 h have elapsed from the time of the injury • Subcutaneous sutures should not be used
Prophylaxis	• Determine indications for rabies and tetanus prophylaxis • Prescribe antibiotics if: ✓ Immunocompromised or asplenic ✓ Moderate to severe puncture wounds ✓ Injuries to the bone, joint capsule, or tendons ✓ Wounds in the face, hand, or genital area
Follow-up	• Wound inspection within 48 h

HBV=hepatitis B virus, HCV= hepatitis C virus, HIV=human immunodeficiency virus.

Bites in the skull of a young infant or toddler may cause penetrating injury to cranial contents; thus, special considerations should be made for antibiotic agents that not only cover for the most likely pathogens but also penetrate the blood-brain barrier appropriately. Intravenous third-generation cephalosporins plus metronidazole, or meropenem alone should be considered for these types of injuries, with the possible addition of vancomycin if there are concerns about methicillin-resistant *S aureus* (MRSA) infection. A multidisciplinary approach with surgical services and infectious diseases consultation is recommended.

The oral agent amoxicillin-clavulanate provides adequate coverage for aerobic bacteria such as streptococci, methicillin-susceptible *S aureus, Pasteurella,* and *E corrodens.* It also covers oral anaerobic bacteria known to have β-lactamase–producing activity, such as *Prevotella* and *Porphyromonas* spp. In children with serious allergic reactions (anaphylaxis, wheezing, angioedema, or urticaria) to penicillin, an extended-spectrum oral cephalosporin (cefpodoxime) or trimethoprim-sulfamethoxazole plus clindamycin is an alternative. (15)

Ampicillin-sulbactam is the intravenous agent of choice when parenteral therapy is indicated. Piperacillin-tazobactam may be used as an alternative. Neither agent provides coverage for MRSA, and adding vancomycin in cases of severe infection may be considered while waiting for the culture results. An optimal empirical antibiotic regimen for children with allergic reactions to penicillin should include an extended-spectrum cephalosporin (ceftriaxone, cefotaxime) or trimethoprim-sulfamethoxazole, in addition to clindamycin, or meropenem alone. Adding vancomycin

TABLE 4. **Empirical Antibiotics for Human or Animal Wounds**

			PENICILLIN ALLERGY	
TYPE OF BITE	**ORAL**	**PARENTERAL**	**ORAL**	**PARENTERAL**
Dog, cat, human	Amoxicillin-clavulanate	Ampicillin-sulbactam	Extended-spectrum cephalosporin or trimethoprim-sulfamethoxazole PLUS clindamycin	Extended-spectrum cephalosporin or trimethoprim-sulfamethoxazole PLUS clindamycin OR carbapenem

(Adapted with permission from American Academy of Pediatrics. Bite Wounds In: Kimberlin DW, Brady MT, Jackson MA, Long SS, eds. Red Book: 2015 Report of the Committee on Infectious Diseases. *30th ed. Elk Grove Village, IL: American Academy of Pediatrics; 2015:205–210.)*

for coverage of MRSA in severe infections should be considered when meropenem is used alone and cultures are pending.

Parenteral or oral extended-spectrum cephalosporins do not provide adequate coverage against some anaerobes, so they should not be used empirically as monotherapy. First-generation cephalosporins do not provide coverage for *E corrodens* and some anaerobes and, therefore, are not recommended as empirical therapy. Doxycycline is an alternative agent that provides coverage of gram-positive aerobic bacteria, including MRSA and the gram-negative rod *Pasteurella*. Azithromycin is a macrolide that shows good in vitro activity against pathogens that commonly cause bite wound infections, but clinical data are lacking to recommend it as a first-line agent. Fluoroquinolones show activity against *P multocida* and some anaerobes. These agents are not approved for this indication in children, but they may be considered in cases of severe infections with susceptible organisms.

Management of tetanus prophylaxis in bite wounds should follow recommendations according to the immunization status of the affected person. When the child has received fewer than 3 doses of adsorbed tetanus toxoid–containing vaccine or the status is unknown, human tetanus immune globulin should be administered along with a dose of age-appropriate tetanus toxoid–containing vaccine. Equine antitoxin may be available in countries where tetanus immune globulin is not. Equine antitoxin is no longer available in the United States. See Table 5 for specific recommendations of tetanus prophylaxis in those who had previously received at least 3 doses of tetanus vaccine. (9)

The animal species is important in determining the risk of rabies exposure. It is encouraged to contact local public health authorities for determining risk. Use of passive and active prophylaxis is ideal once wound care is completed and assessment of the risk warrants postexposure prophylaxis. See the Figure for recommendations for rabies prophylaxis. Rabies prophylaxis should be initiated as soon as possible. Children who have previously completed vaccination regimens or have documented protecting rabies antibody titers should receive only vaccine booster in case of new exposure. Two vaccines are available for use in the United States: human diploid cell vaccine and purified chicken embryo cell vaccine. Unvaccinated immunocompetent children should

TABLE 5. **Tetanus Prophylaxis in Bite Wounds**

	ADMINISTER		
RECEIVED DOSES OF ADSORBED TETANUS TOXOID	**DTaP, Tdap, OR Td[A]**	**TIG[B]**	
<3 doses or unknown		Yes	Yes
≥3 doses	<5 y since last tetanus toxoid–containing vaccine	No	No
	≥5 y since last tetanus toxoid–containing vaccine	Yes	No

DTaP=diphtheria and tetanus toxoid and acellular pertussis vaccine, Td=adult-type diphtheria and tetanus toxoid vaccine, Tdap: booster tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis vaccine, TIG=tetanus immune globulin (human).

[a]*DTaP for children younger than 7 years. Tdap preferred for underimmunized children 7 years or older who have not received Tdap previously.*

[b]*Intravenous immunoglobulin should be used if TIG is not available.*

(Adapted with permission from American Academy of Pediatrics. Tetanus (lockjaw). In: Kimberlin DW, Brady MT, Jackson MA, Long SS, eds. Red Book: 2015 Report of the Committee on Infectious Diseases. *30th ed. Elk Grove Village, IL: American Academy of Pediatrics; 2015:773–778.)*

receive a 4-dose series of rabies vaccines along with a dose of human rabies immune globulin for postexposure prophylaxis. Rabies immune globulin should be infiltrated around the wound, and it should be given on day 0 only. The first dose of rabies vaccine should be followed by 3 subsequent doses of rabies vaccine alone on days 3, 7, and 14 after the first dose. (17) Laboratory work should be obtained to determine antibody protection 7 to 14 days after administration of the last dose. (18)

CONCLUSION

All things considered, animal bites are usually preventable injuries. Clinicians caring for children should investigate what kind of pets the child is exposed to, inquiring particularly about specific breeds of dogs and whether the animals are up to date on immunizations. The American Academy of Pediatrics (AAP) Committee on Infectious Diseases discourages the acquisition and ownership of nontraditional pets in households with young children. Both the AAP and the CDC have parent-friendly tips to prevent animal bites, particularly dog bites. This information should be discussed with the family when possible, and it should be provided to them at the end of a health supervision visit. There are no data to support this action, but we encourage it for primary care practitioners due to the continuously increasing number of pet animals as well as companion and service animals. School-aged children should be included in the discussion about pet safety throughout a health supervision visit. As a final point, the AAP Committee on Infectious Diseases also states that "pediatricians, veterinarians, and other health care professionals are in a unique position to offer advice on proper pet selection, to provide information about safe pet ownership and responsibility, and to minimize risks to infants and children." (18)

Summary

- On the basis of expert consensus due to lack of evidence, primary wound closure for animal bite wounds is recommended only for those to the face. (16)
- On the basis of expert consensus due to lack of strong evidence, from Infectious Diseases Society of America Practice Guidelines for the Diagnosis and Management of Skin and Soft Tissue Infections: "preemptive antibiotic therapy for 3 to 5 days is recommended for patients who are immunocompromised; are asplenic; have advanced liver disease; have preexisting or resultant edema of the affected area; have moderate to severe injuries, especially to the hand or face; or have injuries that may have penetrated the periosteum or joint capsule." (16)
- On the basis of expert consensus and moderate evidence, amoxicillin-clavulanate is the antibiotic of choice for prophylaxis or empirical treatment of an animal or human bite. (15)
- On the basis of expert consensus due to the lack of evidence, postexposure prophylaxis for rabies and tetanus may be indicated. (16)

Take Home Points

- Health-care providers caring for children have a duty to inquire about what kinds of pets the child is frequently exposed to and the immunization status of the animal.
- Health-care providers have the responsibility to counsel families on pet safety.
- Nontraditional pets pose a potential risk of infection and injury, especially for young children and the immunocompromised.
- The American Academy of Pediatrics Committee on Infectious Diseases states that children should be counseled "to never handle unfamiliar, wild, or domestic animals, even if animals appear friendly."
- Health-care providers should counsel families on avoiding ownership or adoption of wild pets or even bringing wild pets into their homes.
- Children should always be supervised when interacting with animals, particularly if they are younger than 5 years of age.
- Amoxicillin-clavulanate is the antibiotic of choice for prophylaxis or empirical treatment of an animal bite.
- Clindamycin plus trimethoprim-sulfamethoxazole is an acceptable alternative for those with penicillin allergies.
- Reviewing tetanus immunization status in a child sustaining an animal bite is an important opportunity to encourage being up to date with the immunization schedule.
- Assessing risk for rabies exposure depending on the nature of the animal inflicting the bite is a key factor to preventing a fatal outcome.

Suggested Areas for Quality Improvement Projects

- Implementation of anticipatory guidance in the health supervision visit regarding animal safety
- Development of standard policies for service animals versus companion animals
- Creation of order sets in electronic health record systems in emergency department and acute care centers aimed to guide practitioners regarding management of human and animal bite wounds

Suggested Websites

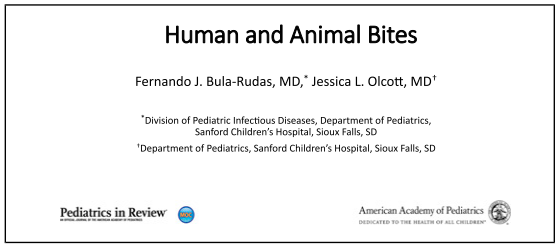
AAP: Dog Bite Prevention Tips 2017 https://www.aap.org/en-us/about-the-aap/aap-press-room/news-features-and-safety-tips/Pages/Dog-Bite-Prevention-Tips-2017.aspx Accessed April 26, 2018.

CDC: Preventing Dog Bites https://www.cdc.gov/features/dog-bite-prevention/index.html Accessed April 26, 2018.

CDC: Zoonotic Diseases https://www.cdc.gov/zoonotic/gi/ Accessed April 26, 2018.

The Humane Society of the United States http://www.humanesociety.org/animals/pets/?credit=web_id93480558 Accessed April 26, 2018.

To view teaching slides that accompany this article, visit http://pedsinreview.aappublications.org/content/39/10/490.supplemental.



References for this article are at http://pedsinreview.aappublications.org/content/39/10/490.

PIR Quiz

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3. To learn how to claim MOC points, go to: http://www.aappublications.org/content/moc-credit.

1. Which of the following healthy and fully immunized 5-year-old girls is most likely to develop bacterial infection at the site of an animal bite?
   A. Home pet cat bite to the face.
   B. Home pet dog bite to the face.
   C. Neighbor pet cat bite to the hand.
   D. Neighbor pet dog bite to the thigh.
   E. Provoked dog bite to the face from an unknown dog.
2. A previously healthy and fully immunized 8-year-old girl is brought to the office with a 1-day history of increasing erythema and pain after a dog bite to her right arm that occurred 3 days earlier from a friend's pet dog. On examination her temperature is 98.9°F (37.2°C) and her other vital signs are normal. There is a 5 × 8-cm area of erythema of her right forearm surrounding the bite wound with a small amount of serosanguinous drainage. The drainage is swabbed and sent for culture. Which of the following organisms is most likely to grow from the culture?
   A. *Clostridium tetani.*
   B. *Eikenella corrodens.*
   C. *Pasteurella canis.*
   D. *Streptococcus anginosus.*
   E. *Streptococcus pyogenes.*
3. A previously healthy 16-year-old boy is brought to the emergency department with increasing pain and redness of his right hand over the past 6 hours. He was in a fight at school yesterday and hit his classmate in the teeth with his closed fist and had a laceration over his third and fourth knuckles. He is afebrile and there is tenderness, swelling, and erythema of the dorsum of his right hand. There is no lymphangitis. Which of the following is the most likely pathogen(s)?
   A. *Aeromonas hydrophila.*
   B. *Bacillus subtilis.*
   C. *Capnocytophaga canimorsus.*
   D. Mixed aerobic and anaerobic bacteria.
   E. *Streptococcus pyogenes* and *Streptococcus agalactiae.*
4. For the same boy in question 3, which of the following is the most likely complication of his infection?
   A. Compartment syndrome.
   B. Nonsuppurative lymphadenitis.
   C. Suppurative lymphadenitis.
   D. Tenosynovitis.
   E. Toxic shock syndrome.
5. A 6-year-old girl with sickle cell disease is brought to the immediate care clinic after a cat bite to the dorsum of her left foot 2 hours earlier from a friend's pet cat. She is not currently taking any antibiotics, and she has no known allergies. She received the recommended immunizations at 5 years of age. Her examination findings are normal except for a puncture wound on the dorsum of her left foot without drainage or surrounding erythema. The wound is cleansed. Which of the following is the most appropriate next step in management?
   A. Administer tetanus immune globulin and tetanus toxoid vaccine.
   B. Administer tetanus toxoid vaccine.
   C. Magnetic resonance imaging of her foot.
   D. Preemptive amoxicillin-clavulanate.
   E. Wound care only with soap and water.

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Human and Animal Bites

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