

**ANN T. KELLEHER, DO**

Dr. Kelleher has completed a fellowship in the Department of Infectious Disease at the Cleveland Clinic, and is a staff physician in the Department of Internal Medicine in the Cleveland Clinic.

**STEVEN M. GORDON, MD**

Dr. Gordon is a staff physician in the Department of Infectious Disease, and hospital epidemiologist of the Cleveland Clinic.

# Management of bite wounds and infection in primary care

## KEY POINTS:

Consider hospitalization for all significant human bites to the hand.

Amoxicillin-clavulanic acid provides adequate empiric coverage for most bite wounds.

In the United States, only wild-animal bites call for rabies prophylaxis.

Prophylactic antibiotic therapy is not routine for fresh, uninfected dog bites, but should be considered for severe crush injuries or distal extremity punctures.

**ABSTRACT:** This article describes how to recognize the signs of septic arthritis and flexor tenosynovitis after dog bites, how to identify the need for prompt surgical treatment of septic arthritis to prevent joint destruction, how to determine which wounds should and should not be sutured, and how to choose effective antibiotic treatment.

Bite wounds can be deceptive, as seemingly minor wounds can penetrate joint capsules and even bone, resulting in serious complications such as septic arthritis. Prompt assessment and treatment, including empiric antibiotic treatment and tetanus immunization, can avert most problems. Yet, many patients will not need such treatment; in fact, even though bite wounds account for approximately 1% of emergency department visits,<sup>1</sup> many more victims probably do not seek medical attention. This article reviews the initial assessment, bacteriology, management, and treatment of dog, cat, and human bites.

## DOG BITES

In their lifetimes, half of all Americans are bitten by a dog or cat.<sup>2,3</sup> In approximately 85% of dog bite incidents, the most common type of bite, the animal was provoked. Men are bitten more frequently than women, and bites occur more often in warm than cold weather months.<sup>4</sup> The most frequent site of injury is the upper extremity. Wounds can vary from scratches and punctures to avulsions and tears.

Approximately 20% of dog bite wounds become infected, and the greatest risk of infection occurs with puncture wounds, crush injuries, and hand wounds.<sup>5</sup>

Infection in a dog bite usually manifests as pain at the wound site with purulent drainage. Early after injury (within 8 hours), clinical signs of infection may be minimal. Fewer than 10% of patients have fever, lymphangitis, or regional adenopathy early after injury.



Bone and joint infections are serious complications of dog bites. Joint pain should alert the clinician to the possibility of septic arthritis. Osteomyelitis usually follows penetrating trauma, as teeth deposit bacteria beneath the periosteum. Septic arthritis and tenosynovitis may result from penetration of the joints and tendon sheaths. Since delay in performing surgical drainage can result in necrosis of the flexor tendon and loss of function, it is important for the primary care clinician to recognize this condition. Arthrocentesis of infected joints often yields purulent material from which pathogens may be cultured.

#### Typical organisms in dog bites

Organisms cultured from infected dog bites reflect the dog's oral flora and include *Pasteurella multocida*, *Staphylococcus intermedius*, *Staphylococcus aureus*, alpha-hemolytic streptococci, *Capnocytophaga canimorsus*, *Eikenella corrodens*, and anaerobic bacteria.

*P multocida* is isolated from 20% to 30% of infected dog bites.<sup>5</sup> An aerobic, facultatively anaerobic, gram-negative coccobacillus, it produces a rapid, intense inflammatory response with prominent pain and swelling. It responds to a variety of antibiotics, but not to clindamycin.

*S aureus* strains are isolated in 20% to 30% of cases and are usually methicillin-susceptible.

*S intermedius*, a coagulase-positive organism found frequently in the oral flora of dogs weighing less than 40 pounds, can be confused with *S aureus* but differs in that it is usually susceptible to penicillin.<sup>6</sup>

*C canimorsus* (formerly DF-2) is a fastidious gram-negative rod that can cause a severe syndrome of sepsis, disseminated intravascular coagulation, and renal failure in immunocompromised hosts (eg, with asplenia, liver disease, or immunosuppressive therapy).<sup>7-9</sup> This organism is usually susceptible to  $\beta$ -lactam antibiotics and fluoroquinolones.

*Alpha-hemolytic streptococci* are the most frequent isolates growing from most wounds, and are susceptible to penicillins and cephalosporins.

*E corrodens* the only species in its genus, is

a nonmotile, slender, facultatively aerobic gram-negative rod that "pits" or "corrodes" the medium on agar plates. It is most commonly isolated from "clenched-fist" injuries. First-generation cephalosporins are inactive against most strains of *Eikenella*.

The anaerobic bacteria isolated from dog-bite wounds include *Actinomyces* species, *Bacteroides* species, and *Fusobacterium* species. These constituents of the oral flora of animals rarely produce  $\beta$ -lactamase.

#### ■ CAT BITES

A greater percentage of cat bites or scratches become infected than do dog bites, ranging from 25% to 50%.<sup>5</sup> Further, cat bites are more likely to lead to septic arthritis or osteomyelitis because the needlelike feline teeth easily penetrate joints and the periosteum of bones.

*P multocida* is isolated more often from infected cat bites (50% to 70%) than from dog bites; otherwise the microbiology of cat bites is similar to that of dog bites.<sup>10</sup>

#### ■ HUMAN BITES

Human bites generally cause more serious infections than do animal bites, because of the bacteriology of the human oral flora and mechanisms of injury (occlusional and clenched-fist injuries). The spectrum of infection varies from cellulitis to septic arthritis and osteomyelitis.

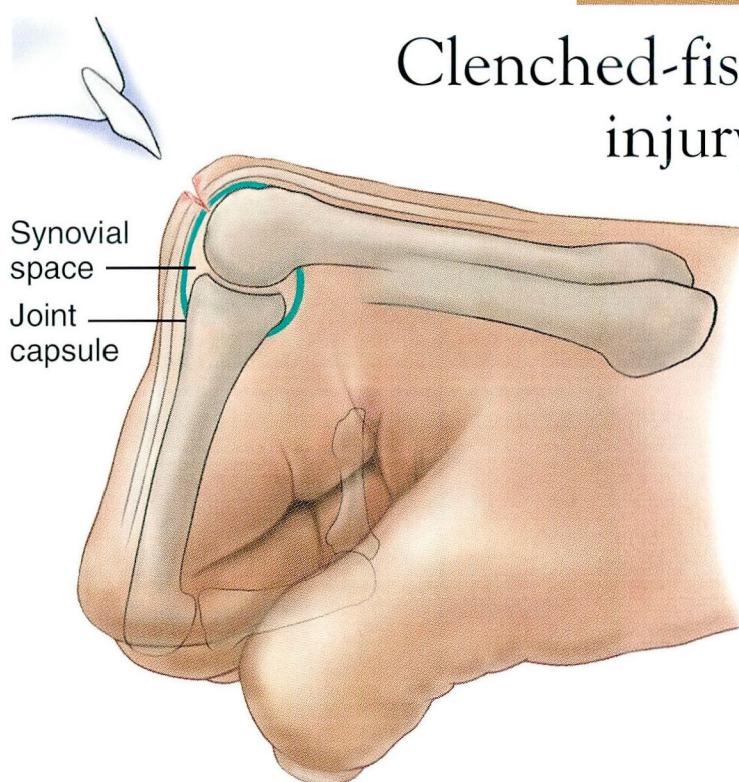
"Love nips" account for 15% to 20% of human bites and are usually related to sexual activity. However, most human bites occur during fights.

**Clenched-fist injuries**, the most serious type of human bites, usually occur at the third metacarpophalangeal joint of the dominant hand (FIGURE). The metacarpophalangeal joints are in flexion at the time of the injury, making it easier for a tooth to penetrate the joint space. When the patient is seen for evaluation (with the joint extended), the overlying skin moves, and the joint penetration is easily overlooked.

Initially, the injury may be small and easily ignored until increasing pain and drainage lead

Delay in performing surgical drainage can result in necrosis of the flexor tendon and loss of function

## Clenched-fist injury



A fist bitten during a fight can look deceptively normal during examination. Clenching the fist during the fight puts the metacarpophalangeal joints in flexion and makes it easy for a tooth to penetrate the joint capsule. After the fight, examining the hand with fingers extended displaces the skin and hides the deeper injury. Undetected and untreated, the injury often becomes infected and can lead to septic arthritis.

flora of the victim (TABLE). Prophylactic antibiotic therapy is not routine for fresh, uninfected dog bites but should be considered for severe crush injuries with significant edema, or distal extremity punctures.

**Amoxicillin-clavulanic acid** (500 mg three times a day) provides excellent empiric coverage. Patients allergic to penicillin can take doxycycline (100 mg twice daily), but this should not be given to children or pregnant women. Quinolones (eg, ciprofloxacin 500 mg every 12 hours; ofloxacin 400 mg every 12 hours) have also been used in adult patients allergic to penicillin.

**Erythromycin, clindamycin, and first-generation cephalosporins** are generally not used for empiric treatment because of their poor activity against *P multocida*.

the patient to seek medical evaluation. Infections are more likely with deeper wounds, certain joint compartments entered (eg, the metacarpophalangeal [knuckle] joints), greater tissue damage, and more pathogenic bacteria.<sup>3,11</sup> If a joint is infected, prompt surgical debridement needs to be carried out to prevent septic arthritis from destroying a joint.

The microbiology of human bite infections reflects the normal oral flora of humans.<sup>12</sup> *Viridans streptococci* are common wound isolates, but empiric antibiotic therapy should include activity against *S aureus*, *E corrodens*, *Haemophilus influenzae*, aerobic and anaerobic streptococci, and oral anaerobic bacteria that produce  $\beta$ -lactamase.

### MANAGING BITE WOUNDS

#### Initial therapy

**Obtain pertinent historical information**, including the type of animal and whether the attack was provoked or unprovoked. This information is important in assessing the need for rabies prophylaxis. Also elicit and clarify any history of drug allergies and underlying medical conditions such as immunosuppressive therapy, splenectomy, or liver disease. Previous tetanus and rabies immunizations should be documented.

**Perform a thorough physical examination**, documenting the location and extent of the wound. Note any bone tenderness, and evaluate any nerve or tendon involvement.

**Irrigate the wound.** Wound irrigation is critically important. Devitalized tissue or foreign bodies should be removed.

**Do not close infected wounds** or wounds more than 24 hours old.<sup>5</sup> Most dog bites can be closed if less than 8 hours have elapsed; however, if sutured, the wound must be carefully debrided. Cat and human bites should be left open, because secondary infection is common.

**Obtain a roentgenogram** if the possibility of bone or joint involvement is high and if there is a possible foreign body (eg, a tooth) in the wound.

**Immobilize and elevate** the wound.

**Obtain Gram's stains and cultures** from all infected wounds before treating them; 90% of infected dog bite wounds yield pathogenic bacteria.<sup>5</sup>

#### Antibiotic therapy

Antibiotic therapy should be based on knowledge of the oral flora of the biter and the skin



TABLE

## ACTIVITY OF ANTIBIOTIC AGENTS AGAINST ORGANISMS TYPICALLY FOUND IN INFECTED BITE WOUNDS

Antibiotic agent	Organisms typically found in infected bite wounds					
	<i>Staphylococcus aureus</i>	<i>Pasteurella multocida</i>	<i>Staphylococcus intermedius</i>	<i>Capnocytophaga canimorsus</i>	<i>Eikenella corrodens</i>	Anaerobes
Amoxicillin-clavulanic acid	Active	Active	Active	Active	Active	Active
Tetracyclines*	Active	Active	Not studied	Active	Active	Less active
Erythromycin†	Active	Less active	Active	Active	Less active	Less active
Penicillin	Inactive	Active	Less active	Active	Active	Active (animal bites) Less active (human bites)
Dicloxacillin	Active	Less active	Active	Active	Inactive	Less active
1st generation cephalosporins	Active	Less active	Active	Less active	Inactive	Less active
2nd and 3rd generation cephalosporins	Less active	Active	Not studied	Active	Active	Active (cefoxitin, cefotetan) Less active (others)
Quinolones	Active	Active	Not studied	Active	Active	Less active
Trimethoprim-sulfamethoxazole	Active	Active	Not studied	Less active	Active	Inactive
Clindamycin	Active	Inactive	Active	Active	Inactive	Active

\*Drugs of choice with penicillin allergy

†Drug of choice in pregnant women with penicillin allergy and in children

The severity of the wound determines the duration of antibiotic therapy. Patients with clean-appearing wounds are generally treated for 1 week; patients with articular and skeletal infections should be treated for 2 weeks or longer.

### Tetanus immunization

Patients previously immunized against tetanus who have not received a booster in the last 10 years should receive tetanus toxoid 0.5 mL subcutaneously or intramuscularly. Patients who have never been immunized against tetanus or whose immunization history is uncertain should receive tetanus immune globulin 250 to 500 U intramuscularly (the dose depending on the severity of the wound), plus the first of three doses of tetanus toxoid, given 1 month apart.

### Surgical consultation

Consider hospitalizing the patient and consulting a hand surgeon for all significant human bites to the hand and bites involving a bone or joint.

### Risk of rabies

Rabies, caused by a highly neurotropic RNA virus, is a widely feared complication of animal bites. In developed countries, vaccination and control of rabies in domestic animals have decreased the number of cases in humans, which have steadily declined in the United States since the 1950s. Only 18 indigenously acquired cases occurred between 1980 and 1995, and dogs accounted for only two of them.<sup>13,14</sup> The principal wildlife vectors in the United States are raccoons, foxes, skunks, and bats. Currently, raccoons account for most

cases of animal rabies, especially in the mid-Atlantic and southeast regions of the United States.

The Advisory Committee on Immunization Practices (ACIP) periodically issues guidelines for treatment following exposure.<sup>15</sup> Two questions should be asked: did an exposure occur, and was the animal rabid?

**Did an exposure occur?** An exposure is defined as an animal bite or contamination of an open wound or mucous membrane with saliva or infected tissue from an animal or human. Thus, rabies can be transmitted to humans by bites or by scratches, abrasions, or contact of mucous membranes or open wounds with infected saliva. Rabies is not transmitted by casual contact (petting).

**Was the animal rabid?** Few dogs in the United States have rabies (except along the Mexican border, where as many as 80% of tested dogs are rabid). A healthy domestic dog or cat that bites a human should be confined and observed for 10 days and postexposure treat-

ment withheld; treatment should be initiated if signs suggestive of rabies develop.

**Prophylactic therapy after exposure** includes local wound care, passive immunization with human rabies immunoglobulin (HRIG; 20 IU/kg), and vaccination (1 mL intramuscularly on days 0, 3, 7, 14, and 28). If the risk of rabies is high, postexposure prophylaxis should be initiated immediately. If the risk is low, treatment can be delayed for up to 48 hours pending laboratory examination. Examination of the animal's brain tissue is the only reliable method of rabies diagnosis. Intra vitam diagnosis of rabies in animals (virus isolation from saliva, viral antigen detection in cranial nerves, and serology) may yield false-negative results in some clinically rabid animals.

Previously vaccinated patients do not need HRIG, but should receive rabies vaccine on day 0 and day 3. In 1994, the median estimated cost for HRIG and rabies vaccine was \$1498 for an adult and \$1127 for a child.<sup>14</sup> ■

## REFERENCES

1. Douglas LG. Bite wounds. *Am Fam Physician* 1975; 11:93-99.
2. US Department of Commerce. Statistical Abstracts of the United States—1992, 112th ed. p. 328. Table no. 392.
3. Goldstein EJ. Bites. In: Mandell D, Bennett JE, Dolin R, eds. *Mandell, Douglas, and Bennett's principles and practice of infectious diseases*. 4th ed. New York: Churchill Livingstone; 1995:2765-2769.
4. Goldstein EJ, Citron DM, Finegold SM. Dog bite wound and infection: a prospective clinical study. *Ann Emerg Med* 1980; 9:508-512.
5. Goldstein EJ. Bite wounds and infection. *Clin Infect Dis* 1992; 14:633-640.
6. Talan DA, Goldstein EJ, Staatz D, et al. *Staphylococcal intermedius*: clinical presentation of a new human dog bite pathogen. *Ann Emerg Med* 1989; 18:410-413.
7. Martone WJ, Zuehl RW, Minson GE, et al. Postsplenectomy sepsis with DF-2: report of a case with isolation of the organism from the patient's dog. *Ann Intern Med* 1980; 93:457-459.
8. Hicklin H, Verghese A, Alvarez S. Dysgonic fermenter 2 septicemia. *Rev Infect Dis* 1987; 9:884-890.
9. Brenner DJ, Hollis DG, Fanning GR, et al. *Capnocytophaga canimorsus* sp. nov. (formerly CDC group DF-2), a cause of septicemia following dog bite, and *C. cynodegmi* sp. nov., a cause of localized wound infection following dog bite. *J Clin Microbiol* 1989; 27:231-235.
10. Holst E, Roloff J, Larsson L, et al. Characterization and distribution of *Pasteurella* species recovered from human infections. *J Clin Microbiol* 1992; 30:2984-2987.
11. Goldstein EJ, Citron DM, Wield B, et al. Bacteriology of human and animal bite wounds. *J Clin Microbiol* 1978; 8:667-672.
12. Brooks I. Microbiology of human and animal bite wounds in children. *Pediatr Infect Dis* 1987; 6:29-32.
13. Fishbein DB, Robinson LE. Rabies. *N Engl J Med* 1993; 329:1632-1638.
14. CDC. Rabies postexposure prophylaxis—Connecticut, 1990-1994. *MMWR* 1996; 45:232-234.
15. CDC. Rabies prevention—United States, 1991: recommendations of the Immunization Practices Advisory Committee (ACIP). *MMWR* 1991; 40(no. RR-3).

**ADDRESS REPRINT REQUESTS** to Steven M. Gordon, Department of Infectious Diseases, S32, The Cleveland Clinic Foundation, 9500 Euclid Avenue, Cleveland, OH 44195.