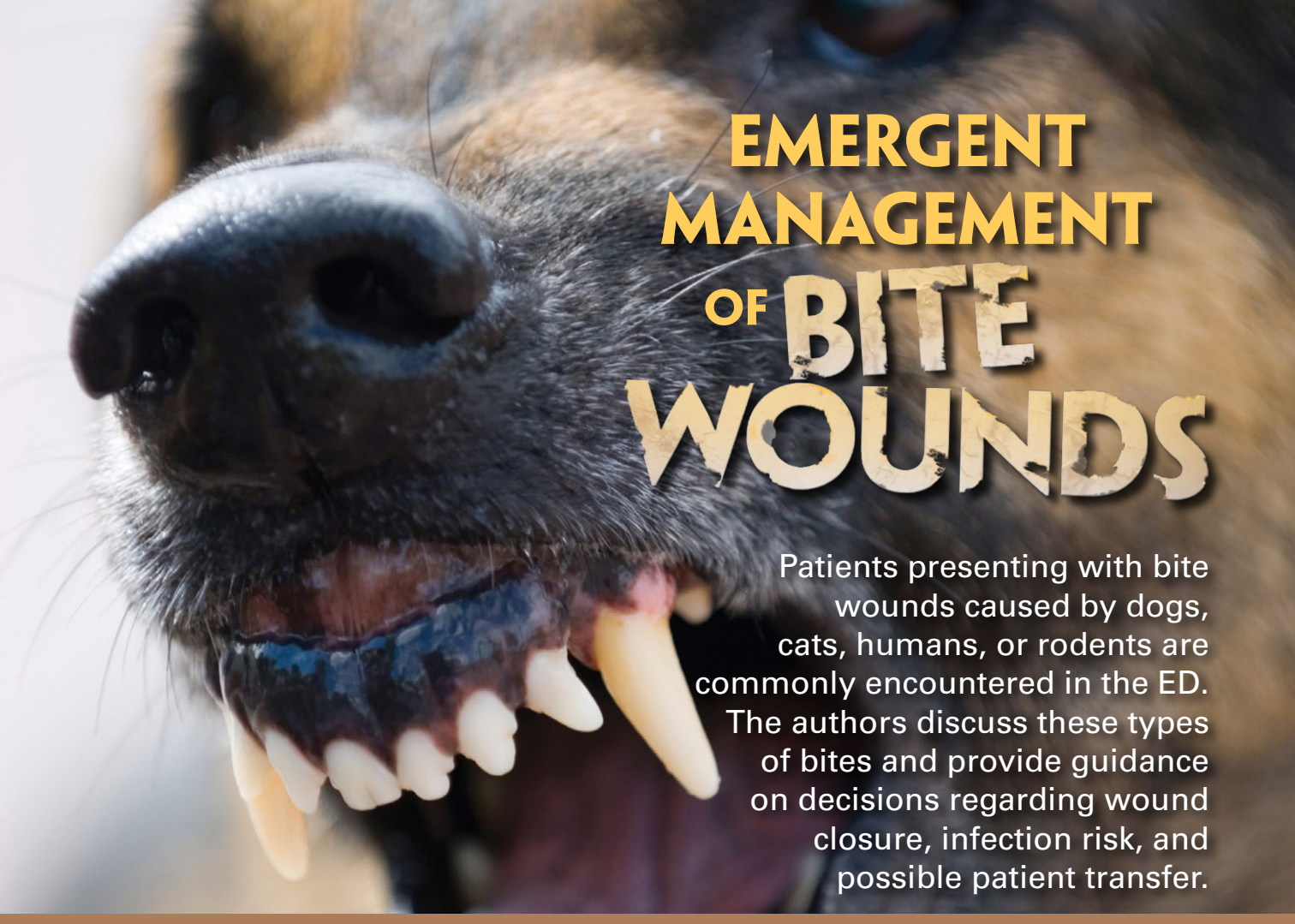

EMERGENT MANAGEMENT OF BITE WOUNDS

Patients presenting with bite wounds caused by dogs, cats, humans, or rodents are commonly encountered in the ED. The authors discuss these types of bites and provide guidance on decisions regarding wound closure, infection risk, and possible patient transfer.

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Bite wounds are a common presenting problem in the ED, with injuries from dog bites occurring most frequently. According to CDC estimates, 4.7 million dog bites occurred in the United States in 1994 (the most recent year for which data can be obtained).[1] It has been reported that dog bites account for 10 to 20 fatalities per year, primarily in infants and younger children.[2] A combination of medical and social factors can complicate basic wound evaluation and treatment. While proper wound care remains the best way to prevent complications, there are special cases that require further treatment.

This article reviews key features of the most common types of bite wounds and outlines the management of these wounds, focusing on evaluation, appropriate wound care, and antibiotic therapy. Special considerations, including administration of human rabies immune globulin and vaccine, as well as indications for emergent transfer, are also discussed. See "Management Points" for a summary of recommendations.

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TYPES OF BITES

Dog Bites

The majority of bite wounds seen in the ED are from dog bites, which account for approximately 85% to 90% of all mammalian bites.[3] Types of wounds inflicted by dogs include lacerations, puncture wounds, and superficial abrasions.[4] The rounded teeth and significant force potential (as much as 450 psi) in larger breeds can cause crush-type wounds that may involve damage to deeper soft tissues, blood vessels, and bone.[5]

Children are commonly injured by dog bites; they may bring an added emotional element to the health

care setting, as often they are frightened and upset. Families are also quite distraught after such an event, which poses a challenge for emergency physicians, who must care for both the physical and emotional needs of the patient and his or her family. Law enforcement and animal control services are often involved for more serious injuries in children. The dog is familiar to the child in the majority (82%) of bite wound cases.[6] The incidence of dog bites increases in the summer months. The highest rate of injury is in children ages 5 to 9 years, while younger children are at increased risk for face, head, and neck wounds because of the proximity to the dog's mouth.[6] Because of the significant force generated, trauma protocols and radiographic imaging are recommended for significant bites to the scalp and face to evaluate for fracture or foreign bodies. In addition, after discharge, the child's primary care physician should be encouraged to watch for signs of posttraumatic stress disorder, given the significant emotional distress that can result from dog bites.[7]

Infections associated with dog bite wounds are usually polymicrobial, with mixed aerobic and anaerobic species; commonly cultured pathogens include *Pasteurella*, *Streptococcus*, *Staphylococcus*, and *Bacteroides* species.[8] *Capnocytophaga canimorsus* infection can, rarely, lead to systemic infection and sepsis; this risk must be considered in immunocompromised patients, who may develop meningitis, disseminated intravascular coagulation, or sepsis.[9]

Overall, infection rates following a dog bite are the lowest among mammalian bites and are similar to those associated with nonbite lacerations, ranging from 3% to 20%.[10] An estimated 4% of facial bites become infected, while the infection rate with hand bites ranges from 28% to 47% due to lesser blood supply.[10]

Cat Bites

Wounds caused by cat bites are the second most common type of bite wounds, accounting for approximately 5% to 10% of all mammalian bite wounds.[3] The majority of the time, these wounds occur in the upper extremities. Compared with other common bite wounds, wounds from cat bites carry a higher risk for infection because cats' sharp, long, slender teeth are better able to puncture deep into tissues and seed bacteria. Dog bites, however, often cause gaping lacerations that can be evaluated and treated more easily.[4] The infection rate with cat bites ranges from 30% to 50%, and the infections are often polymicrobial, with *Pasteurella*, *Staphylococcus*, and *Streptococcus* species cultured most frequently.[10]

Management Points

- Obtain a complete history, including medical history of the patient and vaccination status of both the patient and the animal.
- Consider radiographs if a foreign body or significant crush injury is suspected.
- Perform a thorough neurovascular exam.
- Wound care (inspection, irrigation, debridement) is paramount.
- Be vigilant for infection in delayed presentations of "fight bite" injuries to the hands.
- Transfer patients as appropriate if serious trauma, hand infections, or cosmetic deformities are apparent.
- Consider rabies postexposure prophylaxis (consult CDC guidelines, local animal health authorities).

Human Bites

The third most common type of bite wound, the human bite wound, is associated with many social and emotional issues, as well as a relatively high rate of infection. The extensive pathogenic oral flora of the human mouth leads to infection in 10% to 17% of all bite wounds.[11] *Staphylococcus*, *Streptococcus*, and *Eikenella* species have been isolated. More commonly, the potential pathogens are an extensive mix of aerobic and anaerobic organisms.

Occlusion-type bites are similar to dog and cat bites and involve the sinking of teeth into skin. These may be associated with sporting events, sexual activity, or aggressive play among children. They may also occur in developmentally challenged individuals, persons who have disorders involving self-mutilating behavior (eg, Lesch-Nyhan syndrome), and children and adults affected by assault or abuse.

Clenched-fist wounds, or "fight bites," occur when contact is made with another person's teeth and mouth. These injuries involve the dorsum of the hand, typically near the third, fourth, or fifth metacarpophalangeal joints. The soft tissues of the dorsal aspect of the hand are compact and linear when the fist is closed, but with relaxation, pathogens can travel

into the deeper spaces, creating a more suitable environment for bacterial growth.[12] Presentation to the ED is commonly delayed 24 to 48 hours after injury, and patients may not have classic signs of cellulitis. Swelling and pain with flexion and extension of the fingers are signs that further evaluation, including specialist consultation, is needed. These wounds are at increased risk for deep tissue infection and should be managed judiciously.

Human bites can transmit other pathogens, including hepatitis B virus, hepatitis C virus, and HIV. The risk of HIV transmission through saliva is extremely low, and postexposure prophylaxis is not recommended unless the person inflicting the bite has known HIV infection and skin penetration is involved.[13]

Rodent Bites

Hamsters, gerbils, guinea pigs, mice, rats, and prairie dogs have become increasingly popular as pets; they are also commonly used in scientific laboratories. Although bite wounds from rodents represent the least common type of bite wound, the incidence of bites from these animals depends on proximity to the offending species. Poor sanitation, poverty, structurally unsound buildings, and known rat infestation are conditions that increase the risk for rodent bites, as does working in a laboratory where rodents are kept.

"Rat bite fever," a rare disease caused by *Streptobacillus moniliformis* or *Spirillum minus*, can be transmitted by rats, mice, and squirrels. It is a systemic illness, classically presenting with fever, rigors, and migratory polyarthralgias. Complications include endocarditis, myocarditis, pericarditis, systemic vasculitis, polyarteritis nodosa, meningitis, hepatitis, nephritis, amnionitis, pneumonia, and focal abscesses. Without treatment, the disease is associated with a 10% mortality rate.[14] The main treatment is with penicillin or cephalosporins and clindamycin. Erythromycin may be used in patients with penicillin allergy.

PATIENT EVALUATION

In most cases, patients are able to provide a detailed history of the bite. It is important to note the time of the bite, whether a human or an animal inflicted the bite (if the latter, type of animal must be noted), whether the bite was provoked or unprovoked, and whether prehospital treatment was given. In the case of an animal bite, the vaccination status, health, behavior, and current location of the animal are important in determining the need for rabies prophylaxis.

Additional patient history should be obtained, including allergies, medication regimens, tetanus immunization status, and prior illnesses. It is important to note any immunosuppressive status, as caused by diabetes, lack of spleen function, cancers, or conditions requiring immunomodulatory therapy.

On physical examination, trauma resuscitation protocols should be followed if significant trauma or hemodynamic instability is evident. The remainder of the exam should focus on assessment for neurovascular injury, tendon injury, joint space involvement, bony injury (more common with dog bite injuries in infants), and the presence of foreign bodies.

MANAGEMENT

Wound Care and Antibiotic Prophylaxis

Following initial clinical assessment and stabilization, wound care should begin with the basics of inspection, debridement, irrigation, and closure, if indicated. Inspection of deeper wounds should be performed with analgesia. All borders, including the bottom, should be examined carefully, and injury to important structures must be noted. Debridement of nonviable tissue with proper surgical technique is necessary for prevention of infection.

Irrigation is the most available, inexpensive, safe, and efficacious treatment. A 19-gauge catheter or blunt needle with a 35-mL syringe provides sufficient pressure (around 7 psi) to irrigate most wounds. Approximately 100 to 200 mL of normal saline per square inch is recommended for most wounds.[15] Deep or highly contaminated wounds may require more irrigation and, in some cases, operative care.

Imaging studies such as plain radiographs should be considered in any patient with suspected foreign body or significant crush injury. If the patient's tetanus immunization status is not up-to-date, he or she should be vaccinated. Crush injuries and wounds greater than 1 cm in depth are considered to carry tetanus risk, as are wounds that are contaminated with saliva or dirt.[16]

To close or not to close? There is some controversy on whether to use primary, delayed primary, or no closure with laceration-type bite wounds. Studies looking at bite lacerations have found that wounds on most areas of the body can be closed with a 6% to 7% infection rate, which is similar to baseline wound infection rates.[17,18] For areas of the body where ap-

pearance is a concern, this may be an acceptable rate. Hand wounds, cat bites, and human bites are associated with higher rates of infection; thus, extreme caution is warranted when closure of those wounds is considered.

It is difficult to establish a definite rule regarding which areas to close. Type of animal, depth of wound, wound location, and time from injury are factors to consider. The authors recommend *primary closure* for head, face, and neck lacerations, noninfected wounds incurred less than 12 hours earlier, and wounds to the torso and proximal extremities (except hands), where cosmetic outcome is a concern. *Delayed primary closure* may be considered for wounds of the face and body (nonextremities) that show signs of infection and for wounds incurred more than 12 hours earlier. A period of continued wound care that includes intermittent monitoring for infection and need of debridement, immobilization (if applicable), and antibiotic therapy may be warranted to ensure that the wound is free of infection before delayed primary closure is pursued around 72 hours postinjury.[19] If the wound still appears infected or if it appears that infection is a risk if closure is attempted, then the wound should be left open, with proper wound care, to heal by *secondary closure*. *No closure* is recommended for puncture or crush-type wounds, injuries to the hands and feet (hand wounds have been studied most), clenched-fist injuries ("fight bites"), and wounds with obvious initial signs of infection.

Another area of controversy in wound care is antibiotic prophylaxis. A 2001 Cochrane review revealed that prophylactic use of antibiotics is effective in preventing infection in human bites and bites of the hand but not in other types of bites (including those from cats and dogs).[20] Another study found that wounds from dog bites demonstrate the lowest frequency of infection, whereas those from cat bites appear to develop infection at a significantly higher rate; thus, antibiotic prophylaxis may prove more useful in cat bites in the long run.[21] Although these studies and recommendations provide some guidance, clinicians must exercise their best judgment when determining whether to initiate antibiotic prophylaxis. Proper wound care is always necessary and reduces risk for infection more than antibiotics do. However, because of relatively high rates of infection and the multiple organisms present in bite wounds, the authors use prophylactic antibiotics for at least 5 days in most cases. Antibiotic prophylaxis regimens for adults and children are shown in Table 1.[22] If the patient presents 48 to 72 hours following the bite and there are no signs of infection, it is unlikely that infection will develop, and prophylactic antibiotics are not helpful. Unrestrained use of antibiotics (including unindicated use, use of inappropriate medication regimens, and use for extended periods) contributes to the growing problem of antibiotic resistance and should be avoided.

TABLE 1. Oral Antibiotic Prophylaxis in Dog, Cat, or Human Bite Wounds[a]

Amoxicillin/clavulanate
Adults
875/125 mg bid

Children
>40 kg: 875/125 mg bid; <40 kg: 45 mg/kg (based on amoxicillin component) bid

or

Clindamycin + ciprofloxacin
Adults only
Clindamycin 450 mg tid + ciprofloxacin 500 mg bid

or

Clindamycin + trimethoprim/sulfamethoxazole
Adults
Clindamycin 450 mg tid + trimethoprim/sulfamethoxazole 1 double-strength tablet bid

Children
Clindamycin 10 mg/kg tid (max 450 mg per dose) + trimethoprim/sulfamethoxazole 4-5 mg/kg (based on trimethoprim component) bid (max 160 mg trimethoprim per dose)

[a]Antibiotic prophylaxis is usually given for a 5-day course.
bid = twice daily; tid = three times daily; max = maximum.

Adapted from Abrahamian et al.[22]

Pain Management

Choice of analgesia is variable and multifactorial, depending on the degree of soft tissue injury, patient age, and medical history. During the initial stages of evaluation, it is essential to provide effective analgesia to allow for complete wound care. For deep wounds with significant soft tissue injury, local analgesia in addition to either oral or parenteral opioids should be considered. It is reasonable to offer opioid analgesics for 24 to 48 hours in addition to routine OTC pain medications for wounds with more extensive soft tissue injury.

TABLE 2. CDC Recommendations for Rabies Postexposure Prophylaxis

Animal	Status of Animal	Postexposure Prophylaxis Recommendations
Dogs, cats, ferrets	Healthy and available for 10-day observation	Do not begin vaccination unless animal develops clinical signs of rabies
	Rabid or suspected rabid	Immediately vaccinate
	Unknown (escaped)	Consult public health officials
Raccoons, skunks, bats	Consider to be rabid unless laboratory testing proves otherwise	Consider immediate vaccination
Squirrels, hamsters, guinea pigs, gerbils, chipmunks, rats, mice, other small rodents, rabbits, hares	Consider individually	Consult public health officials; rabies postexposure prophylaxis almost never required

Adapted from Centers for Disease Control and Prevention.[23]

TABLE 3. CDC Recommendations for Use of HRIG and Vaccine in Rabies Postexposure Prophylaxis

Vaccination Status	Intervention	Regimen[a]
Previously unvaccinated	HRIG	20 IU/kg (infiltrate as much of dose as possible around/into wound(s); administer remaining dose IM, at a site distant from site of vaccine administration)
	Vaccine	Four 1-mL IM doses of HDCV or PCECV (give first dose as soon as possible after exposure [day 0]; give remaining doses on days 3, 7, and 14)[b,c]
Previously vaccinated	HRIG	Do not administer
	Vaccine	Two 1-mL IM doses of HDCV or PCECV (one dose each on days 0 and 3)[b]

[a]These regimens are applicable for persons in all age-groups, including children.

[b]Use deltoid area only, except in young children, in whom the outer aspect of the thigh may be used.

[c]For persons with immunosuppression, rabies postexposure prophylaxis should be administered using all 5 doses of vaccine on days 0, 3, 7, 14, and 28.

CDC = Centers for Disease Control and Prevention; HRIG = human rabies immune globulin; IU = international unit; IM = intramuscular(ly); HDCV = human diploid cell vaccine; PCECV = purified chick embryo cell vaccine.

Adapted from Rupprecht CE et al.[24]

Infected Bite Wounds

Wounds with signs of infection, such as erythema, edema, tenderness, red streaking, or pus drainage, should be treated with basic wound care techniques, as described previously. An initial dose of antibiotics is recommended while the patient is in the ED. Hospitalization should be considered in patients with suspected tendon, joint, or cartilage involvement, those with systemic signs of infection, or those who may be unlikely to keep follow-up appointments. If outpatient management is chosen, follow-up should occur within 24 hours. Antibiotic coverage for 7 to

14 days should be provided with antibiotics similar to those used for prophylaxis.

Reporting

Depending on practice location, health departments often require clinicians to report bite wounds. Local authorities should be consulted for specific information and instruction.

Human Rabies Immune Globulin and Vaccination

For bites from domestic animals, local public health authorities should be consulted for recommendations. Bites inflicted by stray or ill-appearing animals warrant heightened suspicion for rabies. Current information is available from the CDC (Table 2).[23]

Patients with bite wounds inflicted by foxes, bats, raccoons, skunks, or rabid or suspected rabid dogs, cats, or ferrets should receive appropriate human rabies immune globulin and vaccination. Current recommendations on human rabies vaccination and immune globulin administration are noted in Table 3.[24]

When to Transfer

Patients with significant trauma, sepsis, cosmetic deformity, loss of limb, complicated wound infection, or need for hand surgical debridement should be transferred to a facility capable of managing these clinical issues.

CONCLUSION

Proper wound care is the foundation of emergent management of bite wounds; however, numerous considerations are involved in the evaluation and treatment of these injuries. A complete medical history must be taken, a physical exam and basic wound care performed, antibiotic coverage and closure concerns addressed, and pain management achieved. In addition, information about the animal (or human) that inflicted the bite, the bodily location of the bite, risk for infection (including rabies), and proper disposition of patients are critical factors requiring the emergency physician's attention. □

REFERENCES

1. Centers for Disease Control and Prevention. Nonfatal dog bite–related injuries treated in hospital emergency departments—United States, 2001. *MMWR Morb Mortal Wkly Rep.* 2003;52(26):605-610.
2. Sacks JJ, Lockwood R, Hornreich J, Sattin RW. Fatal dog attacks, 1989-1994. *Pediatrics.* 1996;97(6 pt 1):891-895.
3. Hodge D, Tecklenburg FW. Bites and stings. In: Fleisher GR, Ludwig S, Henretig FM, eds. *Textbook of Pediatric Emergency Medicine*. 5th ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2006:1045.
4. Kannikeswaran N, Kamat D. *Clin Pediatr (Phila).* 2009; 48(2):145-148.
5. Chambers GH, Payne JF. Treatment of dog-bite wounds. *Minn Med.* 1969;52(3):427-430.
6. Schalamon J, Ainoedhofer H, Singer G, et al. Analysis of dog bites in children who are younger than 17 years. *Pediatrics.* 2006;117(3):e374-e379.
7. Peters V, Sottiaux M, Appelboom J, Kahn A. Posttraumatic stress disorder after dog bites in children. *J Pediatr.* 2004;144(1):121-122.
8. Talan DA, Citron DM, Abrahamian FM, et al. Bacteriologic analysis of infected dog and cat bites. Emergency Medicine Animal Bite Infection Study Group. *N Engl J Med.* 1999;340(2):85-92.
9. Janda JM, Graves MH, Lindquist D, Probert WS. Diagnosing *Capnocytophaga canimorsus* infections. *Emerg Infect Dis.* 2006;12(2):340-342.
10. Griego RD, Rosen T, Orengo IF, Wolf JE. Dog, cat, and human bites: a review. *J Am Acad Dermatol.* 1995;33(6):1019-1029.
11. Lindsey D, Christopher M, Hollenbach J, Boyd JH, Lindsey WE. Natural course of the human bite wound: incidence of infection and complications in 434 bites and 803 lacerations in the same group of patients. *J Trauma.* 1987;27(1):45-48.
12. Goldstein EJC. Bite wounds and infection. *Clin Infect Dis.* 1992;14(3):633-638.
13. Richman KM, Rickman LS. The potential for transmission of human immunodeficiency virus through human bites. *J Acquir Immune Defic Syndr.* 1993;6(4):402-406.
14. Elliot SP. Rat bite fever and *Streptobacillus moniliformis*. *Clin Microbiol Rev.* 2007;20(1):13-22.
15. Brook I. Management of human and animal bite infection: an overview. *Curr Infect Dis Rep.* 2009;11(5):389-395.
16. Bower MG. Managing dog, cat, and human bite wounds. *Nurse Pract.* 2001;26(4):36-45.
17. Chen E, Hornig S, Shepherd SM, Hollander JE. Primary closure of mammalian bites. *Acad Emerg Med.* 2000;7(2):157-161.
18. Maimaris C, Quinton DN. Dog-bite lacerations: a controlled trial of primary wound closure. *Arch Emerg Med.* 1988;5(3):156-161.
19. Morgan M, Palmer J. Dog bites. *BMJ.* 2007;334(7590):413-417.
20. Medeiros I, Saconato H. Antibiotic prophylaxis for mammalian bites. *Cochrane Database Syst Rev.* 2001;(2):CD001738.
21. Smith PF, Meadowcroft AM, May DB. Treating mammalian bite wounds. *J Clin Pharm Ther.* 2000;25(2):85-99.
22. Abrahamian FM, Talan DA, Moran GJ. Management of skin and soft-tissue infections in the emergency department. *Infect Dis Clin North Am.* 2008;22(1):89-116, vi.
23. Centers for Disease Control and Prevention. Rabies. Domestic animals. http://www.cdc.gov/rabies/exposure/animals/domestic.html. Accessed May 26, 2010.
24. Rupprecht CE, Briggs D, Brown CM, et al; Centers for Disease Control and Prevention. Use of a reduced (4-dose) vaccine schedule for postexposure prophylaxis to prevent human rabies: recommendations of the Advisory Committee on Immunization Practices. *MMWR Recomm Rep.* 2010;59 (RR-2):1-9.