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ANIMAL BITE INFECTIONS

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Epidemiology

Animal bites have become alarmingly common and may represent a quiet epidemic. It is estimated that between 1 and 3.5 million animal bites occur annually in the United States.[1] The highest incidence has consistently been in 5-to 14-year-old schoolchildren, who have greater contact with animals, especially house pets, on a daily basis. Boys are more likely to sustain dog bite injuries, twice as often as girls, who themselves are twice as likely to be bitten by a cat. Approximately 90% of all animal bite problems are caused by dogs, approximately 6% to 8% by cats, and the remainder by such varied groups as rodents, monkeys, and horses.[2]

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The severity of this problem can be appreciated from the fact that animal bites account for 1% of all emergency room visits.[1] Furthermore, 1% to 3% of all animal bites require hospitalization for care and, frequently, followup by various medical subspecialists.[3]

Although animal bites occasionally can cause life-threatening dangers, especially to a small child, most often medical concerns are related to infection as a result of the bite. Among animal bite victims who are not immediately hospitalized, infections develop in 4% of dog bite victims and 35% of cat bite victims.[2] The prevention and treatment of these infections raise some of the most controversial questions associated with animal bites.

Microbiology

Most studies show that the bacteria recovered

from infected bite wounds are those that colonize the skin and the oral cavity of animals. These studies indicate that of these microorganisms, *Pasteurella multocida*, a gram-negative facultative anaerobic rod, is the most important pathogen in dog and cat bites. As many as 50% of dog bite infections and 80% of cat bite infections are caused by this microorganism, either alone or as part of a polymicrobic process.[5] Other bacteria commonly isolated from infected animal bites include *Staphylococcus aureus*, Streptococcus species (usually not group A), and other various anaerobic species.

A recent study emphasizes the polymicrobic nature of animal bites and reexamines the importance of anaerobic microorganisms. In this report of infected animal bites, aerobic bacteria were recovered alone in 24% of the cases, anaerobic bacteria alone in 10%, and mixed aerobic and anaerobic pathogens in 66%. It is suggested that the combination of aerobic and anaerobic flora may be synergistic, thereby making the infection more difficult to eradicate. The anaerobic isolates that were found included Bacteroides species (not *B. fragilis*), Fusobacterium, and Peptostreptococcus. This and other studies also have pointed out the importance and frequency of beta-lactamase-producing organisms found in animal bite infections, including *S. aureus* and various Bacteroides species.[6]

To some extent, the frequency of recovering a particular pathogen from a bite may depend on the animal involved. For example, in the case of *P. multocida*, although 50% of dogs and 67% of cats harbor this organism in their mouths, it has been estimated that the chance of acquiring *P. Multocida* infection from cats is at least 10 times greater than acquiring it from dogs.[7]

Although occurring rarely, some microorganisms found in infected animal bites may pose special hazards for particularly susceptible people. For example, a little known gram-negative rod, unclassified but designated CDC DF2, has caused septicemia and endocarditis in immunocompromised patients with DF2 infected animal bites.[8]

Clinical Findings

The likelihood of infection is determined by the location and nature of the bite wound that has been inflicted. Although the vast majority of these animal bite infections are relatively mild and treatable on an outpatient basis, they occasionally can lead to serious infectious complications. More than 10,000 patients are hospitalized each year in the United States because of animal bites and their infectious complications. Severe cellulitis, septic arthritis, recurrent abscesses, tenosynovitis, bacteremia, and brain abscesses are among the serious infections recorded in these hospitalized patients. In one series in which patients hospitalized with animal bites were studied, 4 of 40 patients developed osteomyelitis.[9]

Most physicians, however, are faced with the more common, although less dramatic problem of outpatient-type infections occurring after an animal bite. The incidence of these post-bite infections varies with the species of animal involved. For example, a biting dog may exert between 150 and 200 pounds of pressure per square inch of tissue involved.[10] Therefore, dog bites frequently present as large avulsions, lacerations, or crush-type injuries resulting in large areas of devitalized tissue. These larger wounds are usually easier to debride and clean and, paradoxically, may be less likely to become infected.

Conversely, although cats may be capable of far less biting force, their sharp teeth may produce deeper puncture wounds, often inoculating bacteria several centimeters into tissue through a very small opening. Cleaning of these cat wounds may be virtually impossible. This may account for the fact that almost a third of cat bites become infected.

In addition, the location of the bite wound also may influence the likelihood of infection, regardless of the species involved. For instance, several studies have shown that arm and hand wounds tend to become infected more often than scalp or face injuries.[11] This is particularly important because a third of all dog bites and two thirds of all cat bites occur in the upper extremity. The frequent involvement of the hand in animal bites and the complexity of the hand structure mandate that all animal bite infections in the hand be considered as potentially serious problems.

In general, signs of infection become apparent between 24 and 72 hours following an animal bite. Redness, tenderness, and swelling develop around the site of injury. Frequently, there is a serosanguineous or purulent drainage. Especially when the hand is involved, puffiness in the area of the injury may obscure the exact location of the infection.

When *P. multocida* is the primary pathogen involved in the infection, a more rapid clinical course frequently occurs. Redness and extensive swelling usually begin within 24 hours of the bite and occasionally within 12 hours of the injury. Patients with *P. multocida* bite infections complain of pain and intense local tenderness in excess of
the clinical findings at the time

Most patients with bite wound infections have no fever or a low-grade one and rarely have systemic symptoms. Those patients who appear toxic or systemically ill should be examined carefully for other complications of animal bites, such as cat-scratch fever, abscesses, or osteomyelitis, depending on the time interval since the injury was incurred.

Management

Considerable controversy exists about the appropriate management of animal bite injuries. Generally, questions arise about proper surgical care of the wounds and the prophylactic and therapeutic use of antimicrobial agents.

The surgical approach to animal bite wounds should be based on sound surgical technique and principles. The key elements to surgical care include thorough wound cleaning and judicious debridement. Cleaning can be performed with a povidone iodine solution and fine mesh sponges. In addition to its broad antibacterial activity, povidone iodine solution does not contain detergents, which may be painful and damaging to delicate, exposed subcutaneous tissues. Following cleaning, many authorities recommended irrigation of the wound, if possible, under high pressure with normal saline solution using an 18- or 19-gauge needle with a large (35-ml.) syringe.[12] Debridement of all visible devitalized subcutaneous tissue and skin should be performed in a careful manner on every wound, including small punctures. Of course, very deep wounds may have to be explored during debridement for evidence of damage to tendons, cartilage, or even bone. After debridement, it may be advisable to repeat the irrigation procedure of the newly exposed tissue.

The suturing of animal bite wounds is a very controversial topic with few standardized rules. Noninfected dog bite wounds less then 8 hours old can be closed successfully with a single layer of superficial sutures. There is evidence that sutured dog bite wounds have an infection rate of 2.9%, approximately the same as sutured wounds not caused by bites. However, suturing dog bite wounds that are older than 8 hours is not recommended. Cosmetically unimportant cat bite wounds probably should not be closed, primarily because of the high incidence of subsequent infections.

Anatomical sites that may call for special attention are the face and hands. Relatively fresh wounds of the face usually can be sutured because the rich vascularity of the face results in a low risk of subsequent infection. However, most investigators would probably agree that primary closure of hand wounds is contraindicated. In fact, except for the most superficial hand wounds, many experts believe that specialty consultation and possibly inpatient treatment may be warranted.

Although no single antimicrobial agent may be able to eradicate all of the potential pathogens responsible for animal bite infections, establishing a specific etiology would be very useful. Culturing bite wounds prior to cleaning may reveal microorganisms that have contaminated the wound but are not predictive of those that subsequently may cause an infection [13]. There is little likelihood that bacteria present before a thorough cleaning would necessarily colonize the wound after cleaning. For the same reasons, Gram stains of material from wounds prior to cleaning may be irrelevant.

Because it may be impossible to predict which specific microorganism later may be responsible for a subsequent wound infection, or even if an infection will occur with a given bite wound, several authors have advocated the use of prophylactic antibiotics. Efficacy of prophylaxis has not been demonstrated in the few controlled studies reported. Most of these studies have shown no decrease in bite wound infection when prophylactic antibiotics are used. However, prophylactic use of antibiotics did not predispose wounds to become infected with resistant bacteria.[14] At present, it would appear reasonable to limit the use of prophylactic antibiotic therapy to specific circumstances in which risk of infection and residual deformity is high. These may include deep cat bites, extensive bites of the hand in which tendon sheaths may be involved, and certain wounds of the face. The choice of antibiotics for prophylaxis must be empirical but probably

should be selected based on their activity against *P. multocida*, *S. aureus*, Streptococcus species, and perhaps anaerobes as well. Logical choices might include penicillin V combined with a penicillinase-resistant penicillin or an amoxicillin-clavulanic acid combination.

Infected animal bite wounds also present difficult therapeutic problems. Sutured wounds should be opened, and fluctuant wounds should be incised and drained. The microbiology laboratory can be extremely useful, however, in the medical management of these injuries. Gram stains of purulent material or necrotic tissue should be performed whenever possible. Cultures of the material should include anaerobic as well as aerobic analysis. Anaerobic carrier media should be used for the transport of material to the laboratory. Aspirates are best left in the syringe, with a rubber stopper placed over the tip of the needle after evacuation of air. If possible, the laboratory should be alerted that the specimens are from an animal bite wound. This will enable them to search for unusual organisms that may be present. This is especially true in the case of *P. multocida*, which, in the absence of completed identification procedures, has been identified as *Haemophilus influenzae*, Neisseria species, and Acinetobacter.[15] In addition, the laboratory should be alerted to the possibility of multiple bacterial species present in the specimen received.

Once adequate cultures have been taken, the choice of antibiotics for treatment is based on the usual bacteria expected in animal bite wounds. Penicillin and amoxicillin are quite effective against *P. multocida* but are not effective against many strains of *S. aureus* and some anaerobes. Likewise, penicillinase-resistant penicillins, such as oxacillin, are quite adequate in treating *S. aureus* but may have insufficient activity against *P. multocida*, where as much as 20% may be resistant to these classes of antimicrobial agents.[16]

Based on these facts and our knowledge of the polymicrobic, aerobic, and anaerobic etiology of bite wound infections, it would appear that penicillin V in conjunction with a penicillinase-resistant penicillin or, alternatively, amoxicillin-clavulanic acid combination would be a logical choice to treat infected bite wounds. Patients who are allergic to penicillin can be treated with either erythromycin or with tetracycline (if older than 8 years). It should be kept in mind that some therapeutic failures have been described in *P. multocida* infections treated with erythromycin alone.[17] In addition, it should be noted that when used alone, first-generation cephalosporins and clindamycin also have resulted in therapeutic failures because of the resistance of some anaerobic bacteria to first-generation cephalosporins and *P. multocida* to clindamycin.[18]

Finally, special attention must be given to the possible need for immunoprophylaxis against tetanus, and in some cases rabies, when dealing with every animal bite. Authoritative guidelines, such as The Report of the Committee on Infectious Diseases of The American Academy of Pediatrics, are readily available to aid the physician in making treatment decisions.

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