Animal and human bites : Evaluation and management

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Animal bites and to a lesser extent human bites are common trauma cases in accident and emergency units and their incidence is rising. Bite wounds are often deeper than they appear to be and they are potentially contaminated with uncommon microorganisms. They need careful assessment, thorough debridement and preferably delayed primary closure. Tetanus cover and, although controversial, prophylactic antibiotics should be considered after individual assessment of each case, as the golden first steps for their management.

Considering their peculiar and theoretically preventable character, animal bites and to a lesser extent human bites are surprisingly common occurrences and their incidence is rising (*16, 26*). Although most of them cause relatively minor injuries (*18, 27*), bite wounds serious enough to be treated in the Accident and Emergency (A&E) Department still account for about 0.4% to 2% of all new attendances (*3, 7, 26*). However, certain aspects of the therapeutic protocol remain controversial (*7, 18*).

ANIMAL BITES

An average–sized A&E Department is expected to treat 400 to 500 animal bites each year (*43*). Most epidemiological studies of animal bites are heavily biased by the preponderance of those caused by dogs (*44*), which account for 80% to 90% of all reported cases (*16, 26, 43*). The peak incidence of dog bites occurs among children (*46*). Furthermore, while dog bites most often involve the limbs in adults (*41, 45*), children are more likely to suffer bites on the face and neck because of their small stature (*24, 48*) (fig 3) ; as a consequence, severe dog bite injuries, including fatal ones, are also disproportionately prominent in this age (*27, 33*). Despite their comparable numbers (*19*), domestic cats have been implicated in only 5% to 15% of animal bite wounds (*14, 41*), which is probably an underestimate (*26*). The vast majority of cat bites are located in the hands (*41*), most commonly affecting women older than 20 years of age (*14, 44*).

When infected, most animal bite wounds reveal a polymicrobial flora, mainly of oropharyngeal origin (*5, 14, 29, 44*) from the animal. The most frequent isolates from dog bites are *Pasteurella* species, followed by *Streptococci* and *Staphylococcus*

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Table I. — Organisms isolated from dog bite and cat bite wounds (38)

Organisms	Isolation rate (%)	
	Dog bite wounds	Cat bite wounds
Aerobes		
Pasteurella sp	50	75
Streptococcus sp	46	46
Staphylococcus sp	20	4
Neisseria sp	16	19
Corynobacterium sp	12	28
Moraxella sp	10	35
Anaerobes		
Fusobacterium sp	32	33
Bacteroides sp	30	28
Porphyromonas sp	28	30
Prevotella sp	28	19
Peptostreptococcus sp	16	5

aureus (*3, 18, 35, 41*). The bacteriology of cat bite wounds is less complex, with *Pastereulla* predominating (*14, 35*). *Pastereulla* species is a constellation of Gram-negative aerobic bacteria (*25*), which are of particular importance as bite wound pathogens. Their high isolation rate from infected animal bite wounds (*26, 27*) equals that from the mouth of canines and felines where they are considered true commensals (*44*) (table I). Wound infections due to *Pastereulla* organisms manifest themselves as an intense cellulitis, developing within 24 hours of initial injury (*41, 44*). Bite wounds in which infection develops after 24 hours, on the other hand, are more likely to contain *Staphylococcus* and *Streptococcus* (*14, 41*).

Several other oral commensals of dogs and cats, which have emerged as opportunistic pathogens following bite injuries, have been found in other studies (*19*). Most notably *Capnocytophaga canimorsus*, a fastidious Gram-negative rod, has been strongly associated with overwhelming bite wound sepsis (*26, 44*), particularly in patients compromised by asplenia, cirrhosis or haematological malignancies (*18, 33*). Anaerobic bacteria are commonly isolated in cultures from infected bite wounds (*4, 5*) but in the context of such mixed infections their precise pathogenic role remains to be determined (*7, 27*).

HUMAN BITES

Although not so common as those inflicted by dogs or cats, human bites are considered more serious by most clinicians because of their higher propensity for infection (*3, 16, 23, 30, 33*), a view that may not be true (*8, 25*). The incidence of human bites is unknown (*41*) as most bites are associated with potentially embarrassing social circumstances such as quarrels or extreme sexual activities, which explains the high occurrence of underreporting (*23, 13*). In addition to bites analogous to animal ones, human bites include a specific type of wound named "clenched-fist injury" (CFI), resulting from the forcible contact of the clenched fist of an assailant with the anterior upper teeth of his opponent. Such wounds are most commonly sustained over the third or fourth metacarpophalangeal joint of the dominant hand, affecting almost exclusively adult males (*32, 35*).

Most reports on the bacteriology of human bite wounds are limited to hand bites (*45*). As with animal bites, the bacteriology of human bites is closely related to the indigenous oral flora of the culprit (*3, 18*), with the saliva serving as a culture and inoculation medium for the invasive organisms (*35*). Although many of these are relatively harmless, it has long been known that bacterial scrapings from the oral cavity are capable of producing characteristic soft tissue infections when inoculated subcutaneously into experimental animals, similar to those occurring in human bite wounds (*17*).

Common pathogenic aerobes include *Streptococci*, *Staphylococcus aureus* and *Haemophilus influenzae* (*26*). *Viridans* ("oral") *streptococci* are the most common wound isolates (*38*), whereas *Staphylococcus aureus* infection is usually seen following attempted self-debridement, representing the infective potential of the victim's skin flora (*19*). Anaerobes including *Peptostreptococcus*, *Fusobacterium*, *Prevotella* and *Porphyromonas* have been isolated at a higher rate from these wounds compared to those inflicted by animals (*3, 4*) ; 50% to 90% of human bite wounds reveal anaerobes, almost always as part of a mixed flora (*4, 5*). ß-Lactamase activity has been noted among *Prevotella* and *Porphyromonas* species (formerly 'oral' *Bacteroides*

spp.), rendering the whole flora penicillin resistant (5, 16, 19). Although this phenomenon may justify directing therapy against anaerobes as well (4), some experts (45) suggest that the latter are not of primary concern in the empiric selection of antimicrobial therapy.

Eikenella corrodens, a Gram-negative facultative anaerobe, is a common inhabitant of the human oral flora, which has been increasingly recognised as a potential bite wound pathogen (38). It is particularly implicated in clenched fist injuries (CFIs), 25% of which yield this organism, often as the predominant or sole survivor after empirical administration of antibiotics, accounting for greater morbidity in these wounds (18, 38, 45). The primary oral ecological niche for *E. corrodens* is dental plaque, where it is found more frequently than in saliva (22) ; this may explain its higher incidence in CFIs, as these are usually associated with deeper penetration of teeth than simple bites, due to their impact nature (36).

Human bites have also been implicated as a mode of transmission of hepatitis B and C, tuberculosis, syphilis and even tetanus (6, 15, 26). Furthermore, at least two cases of human bites have been reported, resulting in transmission of human immunodeficiency virus (HIV) (26).

INITIAL EVALUATION

Most bite victims seeking medical care are concerned with the cosmetic sequelae of their wound, the development of wound infection or the prevention of rabies (14). However, in a minority of cases, dog bite-associated trauma may represent a potentially or even immediately life-threatening situation (33, 34) ; this subset of dog bite wounds accounts for an average of 1.4 deaths each year in Germany (37), and as many as 10 to 20 deaths in the United States. Death is usually due to penetrating neck trauma and certain large breeds such as pit bulls, German shepherds and rottweilers account for most of these attacks (26). Direct craniocerebral injuries have also been reported among small children (47). Apparently such cases fall into the realm of advanced trauma life support (ATLS) resuscitation guidelines (15, 23).

Bites in the distal extremities pose different problems as they can easily penetrate into joint spaces and are frequently complicated with fractures and tendon or nerve injuries (15, 16). Therefore, radiographs may be indicated to investigate the integrity of the underlying bones as well as the presence of foreign bodies (26, 29, 34, 35) (fig 1, 2).

Once life- or limb-threatening injuries have been ruled out, the location, type and depth of the wounds are assessed and documented and signs of soft tissue infection (i.e. cellulitis with or without regional adenitis) are sought (14, 18). At the same time a thorough review of the past medical history of the victim and the circumstances surrounding the incident should be obtained. With animal bites this inquiry should include, if possible, the immunisation status of the animal and whether it was provoked, in order to define the possibility for rabies transmission (16, 23, 29, 34).

RISK FACTORS FOR INFECTION

The major clinical significance of bite wounds consists in their potential for local or systemic infectious complications due to the unavoidable contamination of the area with the perpetrator's oral flora (14, 27). In addition to the species of the biter, the likelihood of infection depends on the type of wound and its location, the time from injury to treatment and the general medical condition of the patient (9).

It is widely believed that cat bite wounds are more likely to become infected than dog bite wounds (41) for a number of reasons including the different type of injury and the bacteriology of the wound. Because of the high masticatory forces exerted by canine jaws, dog bites on humans tend to produce a combination of lacerations (often of a tearing or avulsion nature) and crush injuries (16, 27), most of which are relatively superficial and thus amenable to proper wound care. As a result dog bite wounds have an incidence of infection between 4% and 10% (10, 41), which compares favourably with that from simple non-bite lacerations treated in the A&E department (45).

In contrast, cats have slender, pointed teeth that create puncture wounds, inoculating saliva deep

Fig. 1a,b. — Anteroposterior (fig 1a) and oblique (fig 1b) views of a patient's hand after a clenched fist injury. The foreign body seen in the ring finger's MCP joint was proved to be a metallic fragment from the opponent's partial denture.

into underlying tissues (*16, 23, 45*). In addition the *Pastereulla* species most commonly isolated from cat bites (table I) appear to be associated with more serious cases of infection compared with those recovered from dog bite wounds (*25*). In fact, 6% of patients with cat bites ultimately require hospitalisation, almost always due to subsequent infection, as opposed to the 1% of dog bite victims who will be hospitalised, frequently for operative repair (*27, 45*). Simple human bites, mostly crush injuries, are intermediate in terms of infectivity (*34*), with overall infection rates ranging from 10% (*6*) to 17% (*30, 41*). These data refute traditional views regarding human bites as highly infective, which, in retrospect, appear to be influenced by a selection bias in

the older literature towards infection-prone hand bites including CFIs (*8, 34*).

Because of its anatomy, which comprises many well-separated compartments and also the close proximity of numerous joints and bones to the skin surface, the hand is particularly prone to deep-space infections after bite injuries, including septic arthritis and osteomyelitis (*16, 45*). For example dog bites of the hand have an incidence of infection as high as 30% (*10, 26, 27*) whereas human bites to the hand are at even greater risk (*41*), as infection complicates between 25% and 50% of neglected or suboptimally treated cases (*30*). By comparison the face represents the most resistant anatomic location to infectious complications, reflecting the preferential

Fig. 2. — A full thickness dog bite wound in the face of a nine-year old girl, sustained when she tried to kiss her dog while feeding. It was a complicated case since the communication with the oral cavity was recognised only when the sutured skin wound became infected. Subsequently the stitches were removed to establish free drainage.

vascularity of the area, with infection rates ranging from 1.5% to 5% of all facial bite wounds, irrespective of the inflicting species (*8, 48*).

The age of the wound at the time the treatment is initiated is considered an important variant contributing to the risk of infection (*10*) with the critical time period ranging from 12 to 24 hours post-injury (*3, 16*). Thereafter a strong correlation has been found between the delay in treatment, the incidence of infection and subsequent morbidity (*45*). This is however somewhat misleading (*34*) : among the probably large number of patients who do not receive adequate initial treatment, some will present late infection and will seek medical advice at that stage, but one may suspect that many others were bitten, never saw a doctor and never became infected (*39*). Nevertheless, early treatment undoubtedly minimises infectious complications and hastens recovery (*32, 34*).

The problems associated with the presence of these risk factors are seen at their worst with CFIs, area- as well as type-specific human bite wounds with unusually poor prognosis (*13*). This may be due to their location (*8*) and frequent neglect initially, but the decisive aggravating factor as compared to simple bites appears to be the impact nature of the injury resulting in deeper inoculation of oral flora (*2*). Because the injury is inflicted on a fully

flexed knuckle, subsequent fist relaxation changes the arrangement of the openings in the lacerated tissue planes, with the overlying skin retracting proximally and sealing the wound (*40*). Therefore, it is imperative that the injured hand should be evaluated in the clenched fist position to avoid missing deeper wounds ; in fact, any laceration located over the third or fourth MCP joint of an adult male should be considered a CFI until proved otherwise (*34*).

DEFINITIVE TREATMENT

Based on the findings from secondary survey, treatment should be addressed to the need for rabies and tetanus prophylaxis, the prevention or therapy of wound infection and the elimination of any possible functional and cosmetic sequelae (*16*).

Tetanus prophylaxis is an integral part of the treatment of any dog or cat bite (*26, 27*) and should take place in the treatment of human bites too (*40, 45*). Depending on the immunisation status of the patient, the standard of care includes the administration of tetanus toxoid if a booster injection has not been given within the last five years, followed by immunoglobulin administration in non-immune patients (*18*).

Rabies prevention should be considered after dog bites that indicate such measures (e.g. truly unprovoked attacks by stray animals), depending on the local incidence of the disease (*5, 34*). In addition to initial wound management, post-exposure prophylaxis consists in passive immunisation with human rabies immune globulin (HRIG) and active immunisation with the human diploid cell vaccine (HDCV) (*14, 45*). Prevention of HIV transmission using antiviral medications including zidovudine (AZT), lamivudine (3TC), or indinavir (IDV), should be considered in human bites and clenched fist injuries, when particular risk factors are identified in the history (*28*).

Cultures

Routine culture studies of fresh bite wounds are not recommended because they are of little predictive value for future infection (*15*) whereas

the ultimate pathogens are frequently a late feature (*7, 26, 27*). Instead the clinician should determine the spectrum of potentially pathogenic microorganisms having an "educated guess", that is on the basis of the published relevant literature (*18*). Cultures are indicated in cases not responding to previous treatment and for patients at high risk or with systemic signs of infection (*26*). In case of animal bite wounds it should be remembered that bacteriologic diagnosis is greatly simplified by notifying the laboratory of the source of the sample (*14*).

Wound care

Thorough wound toilet remains the mainstay of treatment of all bite injuries and the most effective way to decrease the probability of wound infection (*6, 14, 16, 33*). Typical wound care comprises irrigation, debridement and suturing (*48*). Irrigation of the wound with a non-irritant antiseptic solution such as povidone iodine 1% followed by copious amounts of normal saline decreases the number of invasive bacteria and also helps to remove small foreign bodies embedded into the wound (*27*). In fact, one of the reasons why puncture wounds are associated with high infection rates is the difficulty in performing irrigation through their small opening (*14, 34*). Removal of devitalised crushed tissue should follow by means of superficial debridement (*6, 14*). It has been reported in a study of dog bite wounds (*10*) that debridement resulted in a 30-fold reduction in the incidence of infection. In addition debridement facilitates surgical repair resulting in a smaller scar (*7*).

At least 10% of all bites wounds require suturing (*3, 7*). The long-standing aphorism that these wounds should never be closed for fear of precipitating infection has been questioned, following several studies (*10, 48*) which indicate that most uninfected dog bite wounds can safely be sutured after proper wound toilet. Nevertheless, hand bites inflicted by dogs or any other species should not be closed primarily because of their predilection for infection, with consideration towards either delayed repair or healing by secondary intention (*42*). For similar reasons deep puncture wounds, such as most cat bites, are allowed to heal

spontaneously (*14, 15, 16, 26, 29*). Although little data exist about suturing human bites (*40, 42, 45*), these have few cosmetic indications for primary repair outside the head and neck area (and possibly the female breasts) (*6, 8, 15*). Wounds already infected on arrival at hospital obviously should not be sutured until all evidence of infection has gone (*45*).

Bite wounds under consideration for primary repair should be further assessed on the basis of time elapsed since the bite (*33*) ; in general, suturing of non-facial bite wounds older than 6 to 12 hours is not recommended (*15, 16*). In contrast, facial bite wounds are almost always sutured, even beyond this critical period, as primary repair provides the best cosmetic results (*24*). In fact, in the absence of clinical infection, this practice has been carried out successfully as late as the fourth day after the initial injury (*1*). Major tissue defects, however, may require extensive reconstructive surgery (*23*).

CFIs deserve special mention because once they become infected, usually due to either late presentation or initial misdiagnosis, they may have serious functional consequences (*13, 32*). These wounds, after the radiological examination, should be seen in consultation with an orthopaedic hand surgeon and treated aggressively with irrigation, exploration and antibiotics. The wound is left open to heal by secondary intention and the hand is elevated with a sling above the level of the heart (*8*). In uncomplicated cases physiotherapy usually begins after 3 to 5 days (*18*).

All bite victims treated as outpatients, with the exception of those with most trivial injuries, should return for a routine follow-up visit after 24 and 72 hours. The first 24 hours are more important with cat bites, as *Pastereulla* infections usually become apparent by that time. Furthermore, all patients should be instructed to return at the first sign of fever, increased pain or purulent discharge (*42*).

The role of antibiotics

Whereas antimicrobial therapy is clearly indicated in any infected bite wound (*18*), the need for antibiotic coverage of fresh, initially uninfected wounds to prevent future infection remains controver-

sial (*15, 16, 31*). In this context the term "prophylactic" antibiotic treatment is commonly used ; however, we agree with those authors who state that antibiotic administration in bite wounds is therapeutic by definition, since it is instituted after the wounding (*3, 8*).

With the exception of hand bite wounds the value of "prophylactic" antibiotics has not been proved (*11*). Although several studies on dog bite wounds (considered at a moderate risk of infection) report a decrease in the incidence of infection with the administration of antibiotics (*10*), their results have never reached statistical significance (*10, 11, 41*), because of their inability to accumulate a large sample size. However, the use of agents offering inadequate coverage against certain pathogens, as well as the usual policy of prescribing oral antibiotics in the outpatient setting, often too late to intercept any ongoing infection, may well have contributed to equivocal results (*11, 16*). In fact, a meta-analysis of these studies (*12*) has shown that antibiotics do reduce the incidence of infection in dog bites, although with a significant financial burden, which may be inadvisable in view of the low overall infection risk of these wounds (*11*). Consequently, the current trend is not to give antibiotics routinely (*14, 31*) but to reserve them for high-risk wounds, including puncture wounds (particularly if inflicted by cats), bites to the hand and CFIs, most other human bites, wounds older than 8 hours and wounds in immunocompromised patients (*15, 16, 33, 44*). According to many authors (*7, 34*) fresh dog bite wounds of the face rarely require antibiotics when adequate wound care is provided. However, others favour the use of antibiotics in the same type of injury too, for fear of the poor cosmetic outcome if infection occurs (*29, 44*), which is also our opinion.

INDICATIONS FOR HOSPITALISATION

Although most patients suffering bite wounds can be treated on an ambulatory basis, 1% to 2% require hospitalisation (*7, 18*). In addition to patients with extensive bite injuries or deep structure involvement, hospitalisation is indicated when there are signs of systemic infection, failure of outpatient medical therapy and infection in human bites of the hand (*18, 26, 34, 45*) ; poor patient compliance may also constitute an indication for admission under certain circumstances (*33*). Immunocompromised patients should be considered candidates for inpatient therapy even with purely local signs of wound infection (*26*).

THE SELECTION OF ANTIBIOTICS

In practical terms, empiric antibiotic therapy of animal bite wounds should cover *Pastereulla spp., Staphylococcus aureus, Streptococci* and the various anaerobic species of the animal's oral flora. Human bite wounds can be approached in much the same way, except that *Eikenella corrodens* should be considered instead of *Pastereulla spp.* ; both organisms, however, exhibit similar antibiotic susceptibility patterns. Penicillin or ampicillin provides adequate coverage against *Pastereulla spp.* and most of the other oral flora. However, *Staphylococcus aureus* and almost half of the human oral anaerobes are resistant to these drugs (*5, 18*). Despite prior reservations concerning the drug's safety profile and cost (*8, 14*), there is now a general consensus that amoxycillin/clavulanate is the recommended agent for the outpatient therapy for dog, cat and human bites, if not contraindicated (*16, 26, 43, 44*), as it covers virtually all common bite wound pathogens (*20*) (table II). Parenteral forms of ß-lactame and ß-lactamase inhibitor combinations such as amoxycillin/clavulanate (with or without an aminoglycoside) or ticarcillin/clavulanate are recommended for the inpatient therapy of bite wound infections.

Alternative intravenous antibiotics include cefoxitin, cefuroxime and ceftriaxone (*20, 26, 42*) ; only cefoxitin offers adequate antianaerobic coverage. For patients with a history of major allergy to penicillin optimal therapy is not well established (*19*). Previous recommendations for erythromycin (*8*) have faded out since it became apparent that its poor activity against *Pasteurella spp.* might lead to serious complications (*26*). Furthermore, most strains of *Eikenella corrodens* have

Table II. — Antibiotic susceptibility of common bite wound pathogens (18, 19, 20, 25)

ANTIBIOTICS	Pasteurella spp.	Eikenella cor.	Staph viridans	Staph aureus	Peptostreptococcus spp	Fusobacterium spp	Prevotella-Porphyromonas-Bacteroides* spp		Capnocytophage
							Animal	Human	
Penicillin / Ampicillin	+	+	+	–	+	+	+	±	+
Amoxycillin-Clavulate	+	+	+	+	+	+	+	+	+
Cefprozil	+	±	+	+	–	+	+	±	ND
Loracarbef	+	+	+	+	–	+	+	±	ND
Cefuroxime	+	±	+	+	+	+	+	±	ND
Cefoxitine	+	+	+	+	+	+	+	+	+
Erythromycin	–	–	+	+	–	–	+	±	+
Azithromycin	+	+	+	+	±	±	+	+	+
Tetracyclines	+	+	±	+	±	+	+	+	+
Clindamycin	–	–	+	+	+	+	+	+	+
Ciprofloxacin	+	+	–	+	+	–	–	–	+
TMP-SMX	+	+	+	+	–	–	–	–	–

+ : good activity or clinically effective
± : moderate or variable activity
- : poor activity
* : non-bacteroides fragilis species

been found resistant to erythromycin (*21*). Improved activity against these organisms has been reported with azithromycin (*26*).

Tetracyclines are also good alternatives, but they should not be used in young children and pregnant women (*4*). Clindamycin is a poor choice for bite wound infection prophylaxis because of its lack of activity against *Pasteurella spp.* and *E. corrodens* (*3, 18*) despite its widespread use for the treatment of skin and soft tissue infections. Nevertheless, its combination with ciprofloxacin is currently the recommended treatment for infected bite wounds in penicillin-allergic adults, whereas for allergic children clindamycin plus trimethoprim-sulfamethoxazole is recommended (*26*) (table II).

A three to five-day course is usually adequate for prophylactic therapy (*26*). Several authors addressed the question whether the initial dose should be given parenterally to achieve adequate tissue levels (*8, 11, 14, 16*). For infected wounds the duration of therapy depends on the severity of infection. Most soft tissue infections require no more than 10 to 14 days of antibiotic administration ; however, in case of septic arthritis or osteomyelitis longer courses are needed (*3, 18*).

CONCLUSION

The management and treatment of animal and human bites remain a problem and issue of controversy for the treating physician. The problem is even more highlighted in our "modern times" with the increase of recreation and violence among the members of our society. Detailed history and thorough assessment is of great importance in order to identify the suspicious and potentially dangerous out of the trivial bite wounds. There is consensus about tetanus prophylaxis in all patients, in contrast to prophylactic antibiotic treatment, which is questioned at least as a routine practice. Wound debridement in the appropriate wounds and preferably delayed closure, are currently the suggested guidelines. However, we hope that we have provided an overall view covering all the aspects of the problem for the treating physician to make his own mind in decision-making.

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