CONTINUING MEDICAL EDUCATION

Animal and Human Bite Wounds

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SUMMARY

Background: 30 000 to 50 000 injuries are caused by bites in Germany every year. Dog and cat bites are common, human bites relatively rare. 25% of the victims are under age 6, and 34% are aged 6 to 17.

Methods: This review is based on pertinent literature retrieved by a selective search and on the authors' clinical and scientific experience.

Results: In small children, most bite wounds are on the head and neck; in older children and adolescents, most are on the limbs. Bite injuries range from trivial ones needing no medical intervention to major soft-tissue defects with the loss of functionally important structures. A bite can transmit unusual pathogens from the saliva into the wound. The risk of infection after a bite is 10–20%, and about 30–60% of the infections are of mixed aerobic-anaerobic origin. Prophylactic antibiotics are recommended only for wounds that are considered at high risk of infection in view of their type and location, the species of the biting animal, and the characteristics of the patient.

Conclusion: Structured surgical management of bite wounds is the most important factor in the prevention of infection. High-risk wounds must be differentiated from trivial ones. Interdisciplinary management is advisable for wounds on the hands and face.

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Animal bites are common. 60–80% are caused by dogs, and 20–30% by cats; bites by other animals (rabbits, guinea pigs, hamsters, rats, mice) are much rarer (1–3). The victims tend to be children.

Human bites account for as many as 20% of all bite injuries in some urban areas (4).

The spectrum of injury is broad (4–6), and infectious complications, generally due to unusual pathogens, are common (6–10).

Learning objectives

Readers of this article should become familiar with the medical management of bites and should know

- which patients are at high risk of infection,
- which pathogens are common in bite wounds,
- how these can be demonstrated and when antibiotic treatment is indicated, and
- which surgical treatments are urgently necessary.

Epidemiology

The incidence and type of animal and human bite injuries depend on geographic location, industrialization, and cultural factors.

The incidence of animal bites in the United States is estimated at 200 per 100 000 persons per year. The roughly 100 million dogs and cats in American households cause about 1–2 million dog bites and 0.4 million cat bites annually (4, 5).

In each of two areas in Italy (Bologna and South Tyrol), the incidence of bites was separately determined to be 50–60 per 100 000 persons per year (1, 2).

German epidemiologic data on this topic are imprecise, as animal bites are not legally reportable and no nationwide statistics are kept. Animals live in more than one-third of all German households. In 2010, a total of 3610 incidents involving bite wounds were reported to the German statutory health-insurance carriers; 75% were dog or cat bites (8). The German news media report 35 000 dog bites annually, caused by

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Epidemiology

In industrialized countries, about half of all people are bitten by an animal or a human being at some point in their lives. Bite injuries are not rare in Germany.

BOX 1

A classification of the severity of bite wounds, from Rueff et al. (28)

- **Grade I**
 - Superficial skin lesion
 - Torn skin
 - Scratched skin
 - Bite canal
 - Crushing injury
- **Grade II**
 - Wound extending from the skin to the fascia, muscle, or cartilage
- **Grade III**
 - Wound with tissue necrosis or tissue loss

3.8 million registered dogs and a further ca. 1 million unregistered ones in the country (11). In contrast, a survey conducted by the Allensbach Institute on animals in German households (2012–2014) yielded the following distribution for the year 2013: 11.89 million dogs, 12.68 million cats, 2.6 million birds, 3.52 million fish, 4.35 million rodents, and 2.53 million other animals (IfD Allensbach de.statistica 2014).

Dog bites more commonly affect males, and cat bites more commonly affect females, each in a sex ratio of 2:1. Two-thirds of cat bite victims are aged 20 to 35, while two-thirds of dog bite victims are children or adolescents. 25% of all bite victims are under age 6, while 34% are aged 6 to 17 (4, 7, 9, 10). Animal bites tend to occur in the warmer seasons. In 90% of dog bites, the offending animal is the victim's own or one known to the victim (1–3, 11, e1, e2). Male dogs account for three-quarters of dog bites. Pedigreed and mixed-breed dogs bite with equal frequency (5, 11, e2). Dog bites are usually traceable to a disturbance in the interaction of human being and dog. Often, the animal was frightened, irritated, or disturbed while eating (5, 11, e2, e3).

Medicolegal aspects of animal and human bites

Lethal dog attacks

The German Federal Statistical Office reports that 1–6 persons die in Germany each year as the result of dog bites (11, 12).

Large dogs cause more severe bite injuries than smaller ones. Certain aggressive breeds (pit bull, American Staffordshire terrier, bull terrier, rottweiler, German shepherd) dominate the statistics on lethal dog bites; the laws and regulations for dog-owners in the different federal states of Germany take account of this fact in highly variable ways (11, 12). Attacks with a fatal outcome are usually unobserved (11, 12, e1, e2) and tend to involve victims who cannot defend themselves adequately, i.e. mainly elderly persons and small children. Extensive injury can also result from attacks by more than one dog at a time (11, 12). Severe injuries of the head and neck (posterior and anterior aspects) are most common among children under age 4 (12). The skull of a human infant is small and malleable; thus, a large dog can take an infant's entire head in its jaws and, by shaking intensely, tear it off. In most cases with a fatal outcome, the cause of death is vascular injury leading to exsanguination, traumatic brain injury, decapitation, or air embolism (12, 13).

TABLE 1

Classification of the severity of open dog-bite wounds on the face, from Lackmann et al. (29)

Stage	Clinical features
I	Superficial injury not involving muscle
II	Deep injury involving muscle
III	Deep injury involving muscle, with loss of tissue
IVA	The above, and injury to vessels or nerves
IVB	The above, and bone involvement

Biting animals

Most bites are by cats and dogs; around 90% of biting dogs are the victim's own or one known to the victim. Children are bitten more often than adults.

Clinical findings

70–80% of bite wounds are on the limbs, 10–30% on the head and neck.

BOX 2

Infection rates

Cat bites	30–50%
Human bites	15–25%
Dog bites	5–25%
Overall	10–20%
Hand	18–36%
Arm	17–20%
Leg	7–15%
Face	4–11%

BOX 3

Bite wounds with a high risk of infection

- **Because of the nature of wound:**
 - Deep (punctate), contaminated wounds
 - Wounds with marked tissue destruction, edema, poor perfusion
 - Wounds on the hands, feet, face, and genitals
 - Wounds with suspected joint involvement
 - Bite wounds near a prosthetic joint implant
- **Because of characteristics of the patient:**
 - Impaired immune response (immune deficiency, chronic hepatic disease, asplenism, age <2 years, diabetes mellitus)
 - Pre-existing venous or lymphatic stasis in the area of the bite
 - Prosthetic heart valve
- **Because of the species of the biting animal:**
 - Human bite
 - Cat bite

Human bites

Human bite wounds in the form of oval or semilunar hematomas and abrasions can be seen as the result of sexual crimes, child abuse, and physical altercations (so-called self-defense bites), or even consensual sexual activity (14, 15). Indirect human “bite” wounds caused by a blow from the fist to another person’s teeth have their own specific pattern of injury (known as reverse bite injury, clenched fist injury, or fight bite) (16–19).

Direct occlusion bites manifest a more or less distinct impression of the biter’s teeth; in cases of suspected child abuse, for example, a bite by an adult can usually be reliably distinguished from one by a child (smaller radius, impressions of individual teeth, deciduous dentition). A distance greater than 3 cm between canine teeth indicates that the bite wound was inflicted by an adult.

Bite wounds caused by children who still have their primary dentition are characterized by a distance between molars that is usually less than 2.5 cm (20, e4, e5). Aside from tooth impressions, hematomas and petechiae caused by sucking can also be observed.

The detailed photographic documentation of bite wounds, with a distance scale on all images, is forensically indispensable for the assessment of putative suspects (21). Fresh bite wounds should be swabbed for *DI A* testing, which may enable positive identification of the assailant (14, 22, e6). The skin region that came in contact with the assailant’s saliva is rubbed with specially designed, self-drying *DI A* swabs, which are then sent to a laboratory for testing. Such swabs are available commercially and in the gynecology units of larger hospitals, where they are used for the initial evaluation of victims of sex crimes.

Symptoms and physical findings

The local force of the animal bite causes a crush injury with a variable amount of tissue devitalization (19). Bite injuries range in severity from superficial abrasions, tears, and crush wounds to degloving injuries with major tissue loss, sometimes extending to or including the underlying bone. Perforating and even avulsion injuries of the skull have been described (23–27). Cat bites usually cause punctate injuries with deep inoculation of feline saliva. The physician should bear in mind that the deep anatomic layers of the injured tissue may slide over each other during the bite and then back again

Special features of human bites

Human bites can be either direct (occlusion of the biter’s teeth on the victim) or indirect (e.g., a blow with the fist to another person’s teeth).

Caveat

A bite that appears harmless on the surface may involve clinically significant tissue injury in the depths of the wound!

TABLE 2

Infectious pathogens in bite wounds (25, 35, 36)

Type of bacteria	Dog bites	Cat bites	Human bites
Aerobic	<ul style="list-style-type: none"> – <i>Pasteurella</i> spp. – <i>Pasteurella multocida</i> – <i>Streptococcus</i> spp. – <i>Staphylococcus</i> spp. (incl. MRSA) – <i>Neisseria</i> spp. – <i>Capnocytophaga canimorsus</i> 	<ul style="list-style-type: none"> – <i>Pasteurella</i> spp. – <i>Streptococcus</i> spp. – <i>Staphylococcus</i> spp. (incl. MRSA) – <i>Moraxella</i> spp. – <i>Bartonella henselae</i> 	<ul style="list-style-type: none"> – <i>Streptococcus</i> spp. – <i>Staphylococcus</i> spp. (incl. MRSA) – <i>Eikenella corrodens</i>
Anaerobic	<ul style="list-style-type: none"> – <i>Fusobacterium</i> spp. – <i>Bacteroides</i> spp. – <i>Porphyromonas</i> spp. – <i>Prevotella</i> spp. 	<ul style="list-style-type: none"> – <i>Fusobacterium</i> spp. – <i>Bacteroides</i> spp. – <i>Porphyromonas</i> spp. – <i>Veillonella</i> 	<ul style="list-style-type: none"> – <i>Bacteroides</i> spp.

immediately afterward, potentially leading to an underestimation of the true depth of the injury. On the hands, in particular, the periosteum and joints can be penetrated (4, 7, 25, 26, e7).

Indirect wounds of the fist-against-teeth variety are typically accompanied by injury of the metacarpophalangeal joint capsules and proximal phalanges of the second through fifth fingers (16, 18). Published classifications of the severity of bite wounds (28, 29) are based on the degree of involvement of deeper-lying structures and on the presence or absence of vascular and peripheral nerve injury (Box 1, Table 1).

70–80% of bite wounds are located on the hands, arms, and legs, and 10–30% on the head, nape of the neck, and anterior aspect of the neck (particularly in children under age 10). Up to 90% of bite wounds in children under age 5 are on the face and the anterior aspect of the neck (10, 15, 23, 27).

Infections due to bite wounds

Reported infection rates are given in Box 2. In general, 10–20% of bite wounds become infected, including 30–50% of cat bites, 5–25% of dog bites (30–33), and 20–25% of human bites (4, 14, 19, 30). The risk of infection depends on the nature and site of the wound as well as on individual patient characteristics and the species by which he or she was bitten (Box 3). High infection rates are seen in deep wounds (especially cat bites), contaminated wounds, wounds involving marked tissue destruction, edema, and poor perfusion, wounds on the hands, feet, face, and genitals, and those that involve bones, joints, or tendons (3, 4, 6–9).

Bite wounds at high risk of infection:

Deep or contaminated wounds, wounds with extensive tissue destruction and poor perfusion, wounds on the hands, feet, face, and genitals, and wounds involving bones, joints, and tendons.

neonates and infants are at higher risk of infection than older children, adolescents, or adults. The patients at highest risk are those with immune dysfunction of any cause, e.g., AIDS, hepatopathy (alcoholism), asplenia, cancer, neutropenia, diabetes, and treatment with corticosteroids or immunosuppressants (26, 31–33). Persons without any predisposing factors can also suffer from severe or lethal infections in bite wounds (34, e8–e10).

Bacterial pathogens in infected bite wounds

30–60% of infections in bite wounds are mixed aerobic-anaerobic infections (30, 33, 35) derived from the oral flora of the biting animal or, more rarely, from the victim's skin flora or the environment (25, 30, 32). On average, a cat or dog bite wound contains 2–5 different species of bacteria (32, 35, 36). The number of pathogenic species in the wound depends on its type: 7.5 (median) in abscesses, 5 in purulent wound secretions, and 2 in non-purulent wounds (36). Along with *Staphylococcus* spp. (including MRSA) and *Streptococcus* spp. (including *Streptococcus pyogenes*), the commonly isolated pathogens reportedly include *Pasteurella* spp. (*P. multocida*, *P. canis*, *P. dagmatis*), *Capnocytophaga canimorsus*, anaerobes (*Fusobacterium* spp., *Prevotella* spp., *Bacteroides* spp., *Porphyromonas* spp.), and others (e11, e12) (Table 2).

Streptococci can be isolated from 50% of human bite wounds, *Staphylococcus aureus* from 40%, and *Eikenella corrodens* from 30%. It is commonly accepted that the pathogen most often leading to infection is *E. corrodens*, a Gram-negative microaerophilic bacillus (30, 32). Human bites can transmit HBV, HCV, and HIV; post-exposure prophylaxis should be considered in every case (16).

Higher risk of infection in cat bites

Cat bites on the hand are at high risk of infection.

TABLE 3

Pathogens that cause systemic infection after bites by various species

Dog	Cat	Rodent	Rat	Monkey	Various animals	Man
<ul style="list-style-type: none"> – <i>Leptospira</i> – Rabies virus – <i>Clostridium tetani</i> – <i>Francisella tularensis</i> 	<ul style="list-style-type: none"> – <i>Bartonella henselae</i> – <i>Francisella tularensis</i> 	<ul style="list-style-type: none"> – <i>Leptospira</i> 	<ul style="list-style-type: none"> – <i>Spirillum minus</i> – <i>Streptobacillus moniliformis</i> 	<ul style="list-style-type: none"> – <i>Herpes simiae</i> (B virus) 	<ul style="list-style-type: none"> – <i>Brucella</i> 	<ul style="list-style-type: none"> – HBV – HCV – HIV – <i>Treponema pallidum</i>

Rodent bites seldom lead to infection; when they do, the usual pathogen is *P. multocida*. Other rare diseases that can be transmitted by rodent bites are rabies, tularemia (*Francisella tularensis*), and rat-bite fever (*Streptobacillus moniliformis* or *Spirillum minus*) (e13, e14). Aside from wound infections, bites can also cause systemic bacterial infection. Moreover, attention should be paid to cutaneous or mucosal contact with contaminated animal urine or feces or with contaminated water (e15) (Table 3).

Symptoms and physical findings of infection

The manifestations of infection arise within 12–24 hours with *P. multocida* and somewhat later with other pathogens. *C. canimorsus* infection sometimes does not become symptomatic until 5–8 days have elapsed (32, 33).

Findings suggesting infection include redness, swelling, purulent secretion, pain, fever, and malaise. Infected bites are usually in soft tissues (mainly on the hands, but also the head and neck in small children) and thus present with cellulitis or a phlegmon with abscess formation and lymphadenopathy. Tenosynovitis and joint empyema are common in the hands (4, 7, 18, 19, 24–26).

Rarely, local infection in a bite wound progresses to systemic sepsis. Osteomyelitis, arthritis, meningitis, endocarditis, endophthalmitis, and organ abscesses (brain, liver, lung) have been reported (4, 31, 33, e12, e16). Of all pathogens, *Capnocytophaga canimorsus* is the most likely to give rise to acute sepsis, potentially leading to disseminated intravascular coagulation, gangrene, renal failure, and death, especially in predisposed patients (e8, e9, e16).

Diagnostic evaluation

The diagnostic algorithm (Box 4) consists of directed history-taking (including vaccination status), risk-factor

assessment, a general physical examination, and wound inspection to assess the degree of involvement of muscle, joint, vascular, and nervous tissue and to detect signs of infection. If a fracture or a foreign body in the wound is suspected, imaging studies such as plain x-ray, CT, or MRI are indicated; ultrasonography can be used to assess soft-tissue fluid collections or suspected abscess formation.

If a bacterial infection is suspected, the laboratory assessment should include blood tests (complete blood count, CRP/PCT, serology, coagulation studies, blood cultures), a lumbar puncture for CSF analysis, wound punctures and swabs, and stool analysis (microscopy, culture, PCR). An examination of the offending animal (swabs for bacterial culture, stool analysis) should also be requested.

It is vitally important to give the laboratory adequate information on the individual case, because special methods (nutrient plates, anaerobic culture technique) may well be indicated, along with rapid transport times and long incubation times (7–10 days), and unusual pathogens are to be expected (34, 38). In particular, attention must be paid to suitable transport media for anaerobes.

Treatment

There is a clinical consensus that patients can be divided into low- and high-risk groups depending on the cause, nature, and location of the injury and on patient characteristics, but no evidence-based guidelines are now available. It is nonetheless clear that the quality of the initial medical care of the patient has a major effect on the long-term functional and esthetic outcome.

Patients and physicians often underestimate the seriousness of smaller injuries, particularly because punctate skin lesions may conceal the true depth of the injury. Surgical treatment is based on the removal of necrotic tissue, mechanical reduction of the burden

High-risk patients

There is a high risk of infection in patients with asplenism, hepatic cirrhosis, diabetes mellitus, immune deficiency, and implants.

The main pathogens

Most infections are due to mixed aerobic-anaerobic pathogens. The most common organisms are *Pasteurella multocida* and *Capnocytophaga canimorsus*.

BOX 4

Practical clinical algorithm for initial management

- **History**
 - Time, place, and circumstances of the bite, including any provoking factors
- Animal**
 - Species, owner
 - State of health and any unusual symptoms (rabies)
 - Vaccination status
- Patient**
 - Underlying illnesses
 - Implants (e.g., prosthetic heart valve)
 - Immunosuppression
 - Asplenism
 - Allergies
 - Vaccination status
 - Symptoms (pain, pressure, fever)
- **Physical examination**
 - Symptoms of shock, fever, pain
 - Site, nature, and extent of wound, foreign bodies, inflammation, secretion, lymphadenopathy, hypoperfusion (vascular injury, compartment syndrome),
 - Functional deficits of muscles, nerves, and/or tendons
 - Impaired joint mobility
- **Ancillary testing**
 - Complete blood count (anemia, incipient infection)
 - Tissue swab/secretion sample for bacteriological culture (colonization, infection)
 - Plain films (fracture), CT/MRI (head injury)
- **Dokumentation**
 - Photographic documentation of the wound and comprehensive written documentation of the history and physical findings

BOX 5

General measures for local treatment and infection prophylaxis

- **General measures**
 - Cleansing (e.g., with 1% organic iodine solution)
 - Irrigation (normal saline)
 - Debridement of devitalized tissue
 - Primary wound closure or healing by second intention
 - Limb immobilization
 - Inpatient treatment/outpatient follow-up
- **Infection prophylaxis**
 - Indications for immunization
 - Tetanus
 - Rabies
 - Antibiotics
 - Wounds with a high risk of infection
 - Reporting to the authorities, if legally mandated

of pathogens, and optimization of the microcirculation in the injured area. Surgical treatment should be performed under analgesia/sedation or general anesthesia in children, and in adults as well if indicated by the findings and the predicted duration of the procedure. Depending on the site and extent of the bite wound, interdisciplinary collaboration may be advisable.

The surgical treatment includes general measures of local therapy as well as infection prophylaxis. For children, the pertinent S1 guideline of the AWMF (Association of Scientific Medical Societies in Germany) was updated in 2014 (I o. 006/129) (Box 5).

Wound irrigation

Deep irrigation of the wound through an infusion catheter or button cannula serves to remove foreign bodies and pathogens. Irrigation under pressure is inadvisable, as it may lead to the uncontrolled spread of bacteria into deeper tissue layers or (if octenidine/phenoxylethanol is used) aseptic necrosis (e17, e18).

Irrigation is usually with normal saline; a few authors recommend antiseptic solutions (19, e19, e20).

Typical symptoms and signs

P. multocida infections are characterized by the relatively early development of severe pain and inflammation.

Pathogens in human bite wounds

The most commonly isolated pathogen in human bite wounds is *Eikenella corrodens*.

TABLE 4

Recommendations on post-exposure immune prophylaxis for rabies (from STIKO, Epid Bull 34/2014)

Degree of exposure	Nature of exposure: type of animal contact	Immune prophylaxis
I	Touching/feeding the animal, licking of intact skin by the animal	No immunization
II	Non-bleeding, superficial skin scratch or abrasion; licking or gnawing of non-intact skin by the animal	Active immunization
III	Bite wound, scratch wound, contact of mucous membranes or wounds with the animal's saliva (licking), any contact with a bat	Active and passive immunization

Debridement

I ectrosectomy for the removal of torn, crushed, and devitalized tissue is superior to irrigation but often limited by the anatomical situation.

Surgical debridement of head and face wounds cannot be performed as extensively as on the limbs, where effective methods are available to reconstruct the tissue defects that arise (19, 23). Joint involvement sparing the cartilage can be treated with antiseptic irrigation and drainage. For clenched fist injury, the affected joint or joints should be treated with extensive debridement, tenosynovectomy, irrigation, drainage, and daily hand baths. Postoperative immobilization and early functional physiotherapy are needed (18, 19, 23). For infected joints, a planned surgical second look roughly 48 hours later is needed to prevent joint destruction and immobility. In general, second-look operations should be performed in 1–2 days in all cases with extensive necrosis (18).

Wound closure

There is a clinical consensus that wounds in the face should be closed primarily (37). Today, primary replantation and plastic surgical reconstruction with ear cartilage grafts can also be performed successfully (6, 27, e17, e21–e24). For wounds on the limbs, the existing recommendations are still inconsistent (27, e19, e20). It is generally accepted that the usual 6- to 8-hour time limit for primary suturing can be extended to 12 hours or longer. Multiple recent studies have shown that wound infection is no more common after primary suturing of bite wounds than with healing by second intention (e22, e24). Dog-bite wounds of the face can be primarily sutured even if several days old (e17). Primary closure is contraindicated for puncture wounds

with deep inoculation of pathogens (typically cat bites), bite wounds on the hands (18), and human bites (except on the face).

Prophylactic antibiotics

Universal prophylaxis with antibiotics is not recommended. The comprehensive meta-analyses of Medeiros et al. in the Cochrane Database (38) yielded no evidential basis for a reduction of the infection rate by prophylactic antibiotics, except for bite wounds on the hands (39).

Despite the poor state of the evidence, most experts recommend early antibiotic treatment for 3 to 5 days for fresh, deep wounds and wounds in certain critical bodily areas (hands, feet, areas near joints, face, genitals), for persons at elevated risk of infection, and for persons with implants, e.g., artificial heart valves (25–27, 30, 31). In contrast, antibiotics need not be given if the patient presents 24 hours or more after the bite and there are no clinical signs of infection (31).

Targeted antibiotic treatment

Targeted antibiotic treatment is given for manifest bacterial infections (33).

Its varieties include:

- Aminopenicillin + a beta-lactamase inhibitor (oral, intravenous)
- Piperacillin/tazobactam (intravenous)
- Carbapenem (intravenous)
- Cefotaxime + metronidazole
- Possibly, cipro-/moxifloxacin + clindamycin (in case of penicillin allergy)
- I o monotherapy with flucloxacillin, first-generation cephalosporins, erythromycin, clindamycin.

Diagnostic evaluation

Proper bacteriological evaluation requires effective collaboration with the laboratory (transport media, special testing methods).

Treatment

Surgical debridement is superior to irrigation alone. Prophylactic antibiotics are indicated only if there is a high risk of infection. Manifest infections are treated with targeted antibiotics.

BOX 6

Rules on how to prevent dog-bite injuries in children

- **Children should:**
 - Keep well away from strange dogs
 - Not play with dogs unless supervised by an adult
 - Never disturb a dog while it is sleeping, eating, or caring for puppies
- **Parents should:**
 - Teach children early how to behave with their own dog
 - Teach them what to do if approached by a strange dog
- **Dog-owners should:**
 - Keep dogs with a known history of aggressive behavior out of households with children
 - Train dogs properly (hierarchical behavior: the owner is boss)
 - Avoid aggressive play with dogs
 - Seek professional advice if a dog starts to behave aggressively

Clindamycin, macrolides, isoxazyl penicillins, group I cephalosporins, and aminoglycosides are ineffective for the treatment of *P. multocida* and should not be used. *C. canimorsus* strains are also aminoglycoside-resistant. In the future, moxifloxacin may play a role in the treatment of such infections (e25).

The duration of antibiotic treatment depends on the severity of the condition, the extent of spread of the infection, the pathogen, and treatment response. Along with the clinical findings, the CRP value is a useful indicator of treatment efficacy (33).

Recommended duration of antibiotic treatment

- Cellulitis or abscess: 1 to 2 weeks
- Tenosynovitis: 2 to 3 weeks
- Osteomyelitis, arthritis: 3 to 4 weeks.

Vaccination status and immunization

Tetanus—The management of bite wounds includes, as an obligatory component, the ascertainment of the patient's current tetanus immunization status by inspection of the immunization passport. The German Standing Committee on Vaccination (ständige Impfkommision, STIKO) recommends active immunization as the most reliable form of prophylaxis. If

there is any doubt whether the patient is adequately immunized against tetanus, full vaccination should be provided (40). Vaccinations of further types may be advisable if the bite took place in a foreign country.

Rabies—In Europe, the incidence of rabies in human beings is very low, yet dogs are still a more common source of human rabies than wild animals. Small rodents, such as mice and rats, are rarely carriers of rabies. Extensive information on rabies epidemiology in Germany is found in the epidemiological bulletin of the Robert Koch Institute (e26).

There is a potential rabies exposure from any scratch or bite wound by an animal that may be infected, or from contact of such an animal's saliva with a human being's mucous membranes. The decision whether to give post-exposure prophylaxis largely depends on the nature of the contact, the species of the animal, and the current rabies situation in the local geographical area. An animal is not considered to be a potential carrier of rabies if it has lived exclusively in a rabies-free area and has had no contact with animals from endemic areas (e.g., dogs illegally imported to Europe). In case of doubt, the local veterinary authorities must be consulted. The vaccination status of the dog should be ascertained if possible; if it is unknown, the dog should be kept under veterinary observation for 10 days and the bite victim should be given rabies prophylaxis, strictly following the recommendations (40, e27, e28). Instructions for evaluating the risk of rabies and for further steps that may need to be taken are found in the recommendations of the German Pediatric Infectious Disease Society (Deutsche Gesellschaft für Pädiatrische Infektiologie, DGPI) and the STIKO (Table 4), (e28–e30).

Cleansing the wound is an important post-exposure measure. The bitten or otherwise injured skin site should be washed for several minutes with soap and water, then disinfected with 70% alcohol or iodine solution and kept primarily open. For punctate wounds, depending on their location, careful excision of the wound edges may be advisable.

Information for physicians on immunization depending on the degree of exposure is found in Table 4.

Detailed information on the prevalence of rabies in animals and humans in different countries can be found on the website www.who-rabies-bulletin.org. Recommendations on rabies prophylaxis for travelers are given in www.cdc.gov/travel/vaccinat.htm.

Hospitalization

Hospitalization and consultation of a hand surgeon are necessary for all bite wounds of the hand that involve the bones and/or joints.

Vaccination

All patients who have sustained animal bites must have their immunization against tetanus checked and, if necessary, updated.

The duty to report rabies and exposures to rabies

By German law (§ 6 IfSG), physicians must report any patient by name who has or is suspected of having rabies or who dies of the disease, as well as any case of the injury of a human being by a rabid or potentially rabid or rabies-transmitting animal, or any human contact with such an animal, living or dead.

Preventing animal bites

Animal bites are preventable injuries. Preventing them is a task for society as a whole: appropriate rules for animal care must be in effect, animal owners must have the necessary social competence, and children must learn how to behave around animals (e31, e32). Education has not yet been empirically shown to lessen the rate of injury (e31). In Germany, a course given by veterinarians to dog-owners, leading to a certificate of basic competence in risk avoidance, is considered a success (e33). Recommendations for parents, children, and dog-owners on how to prevent dog bites are given in *Box 6*.

Conflict of interest statement

The authors state that no conflict of interests exists.

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Rabies prophylaxis

Rabies prophylaxis is rarely necessary. It is given after evaluation of the risk and in coordination with the local veterinary authorities.

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Question 1

The bites of what animal are most likely to become infected?

- a) Dog
- b) Cat
- c) Wolf
- d) Rat
- e) Reptile

Question 2

What bacterial pathogen is most commonly found in infected human bites?

- a) *Staphylococcus*
- b) *Streptococcus*
- c) *Pasteurella multocida*
- d) *Capnocytophaga canimorsus*
- e) *Eikenella corrodens*

Question 3

What bacterial pathogen in bite wounds causes especially severe and often lethal infections?

- a) *Staphylococcus*
- b) *Streptococcus*
- c) *Pasteurella multocida*
- d) *Capnocytophaga canimorsus*
- e) *Eikenella corrodens*

Question 4

What type of antibiotic is best given to an otherwise healthy patient who develops a manifest infection in a bite wound?

- a) Aminoglycosides
- b) Macrolides
- c) Aminopenicillins and β -lactamase inhibitors
- d) Gyrase inhibitors
- e) Second-generation cephalosporins

Question 5

A young female athlete is bitten in the calf by a Yorkshire terrier while jogging and comes immediately to your medical office. You diagnose a superficial injury without muscle involvement. What should you do next?

- a) Cleanse and irrigate the wound and check the immunization status of the patient and the animal that bit her
- b) Give antibiotics and order lymph drainage
- c) Report the case to the veterinary authorities and send the patient to a dermatologist
- d) Consult with the dog-breeder and notify the pertinent regulatory authorities
- e) Admit the patient to the hospital and obtain a plain x-ray of the leg

Question 6

Which of the following are signs of infection in a bite wound?

- a) Redness, swelling, pain, secretion
- b) Throbbing, headache, shaking chills
- c) Muscle spasms
- d) Sensory disturbances
- e) Hematomas or petechiae

Question 7

Which of the following should be performed urgently after an animal bite?

- a) Irrigation
- b) Second-look surgery
- c) Immediate antibiotic administration
- d) Hepatitis vaccination
- e) Hand bath and open wound care

Question 8

A 7-year-old girl is brought to you immediately after being bitten by a cat. She has a superficial hand wound without any discernible bite canal. What should you do at once?

- a) X-ray the hand
- b) Suture the wound
- c) Give antibiotics
- d) Soak and immobilize the hand
- e) Rule out a fracture and immobilize the hand

Question 9

Which of the following is a feared complication of an infection resulting from a blow with the fist to another person's teeth?

- a) Fracture of the phalanges
- b) An unsightly scar
- c) Joint destruction and immobilization
- d) Fingertip hypesthesia
- e) Trophic nail abnormalities

Question 10

What rule should dog-owners follow so that their dogs will not bite children?

- a) Dogs with a known history of aggressive behavior do not belong in households with children.
- b) Puppies being harmless, children may be allowed to play with them out of the sight of an adult.
- c) Team-oriented dog training, in which the dog is accepted as an equal partner in the hierarchy, is essential.
- d) Children should be taught to approach strange dogs without fear or hesitation, because dogs think of children as puppies to be protected.
- e) Trained hunting dogs can be kept in households with small children without any danger.

CONTINUING MEDICAL EDUCATION

Animal and Human Bite Wounds

Karin Rothe, Michael Tsokos, Werner Handrick

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