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Management of mammalian bites

Background
Mammalian bites are a significant public health problem in Australia, with the majority of bites coming from dogs. Complications include tissue damage from the bite itself, infection and post-traumatic stress disorder.

Objective
This article describes the assessment and management of mammalian bites in the Australian general practice setting based on a PubMed search of the English language literature from the years 1966 to present.

Discussion
General practitioners need to be familiar with the treatment of animal bites, pitfalls in management, and the need to educate patients on ways to avoid future bite injuries. Meticulous wound cleaning, irrigation, exploration and debridement is essential to bite wound healing. Recognition of complicating fractures with imaging is important. Risk of infection differs among animal species, although most infected bite wounds are polymicrobial.

Australia has one of the highest incidences of pet ownership in the world[1] with the rate of dog ownership by household between 35–42%.[2,3] Mammalian bites, in particular dog bites, are common. In Australia, it has been estimated that approximately 2% of the population is bitten by a dog annually, of which 100 000 will require treatment and 13 000 will seek treatment in a hospital.[4]

Dog bites constitute the majority (85–90%) of animal bites followed by cats (5–10%), humans (2–3%) and rodents (2–3%).[5,6] However, any animal with teeth can bite and there are reports of bites from livestock[7–9] and native Australian animals.[10]

Risk factors for dog bites include[3]:

- children under 5 years of age
- male gender
- households with dogs, and
- male, unsterilised dogs.

Sixty-six percent of dog bite victims are bitten by their own dog or an animal that is known to them; about half are unprovoked.[11] Certain breeds are over represented. A study in Adelaide (South Australia) demonstrated that three-quarters (75%) of dog attacks were caused by german shepherds, pit bull terriers, blue/red heelers, dobermans, and rottweilers, despite the fact that these breeds only accounted for 31% of the dog population.[4] Knowledge of these risk factors is important to help design campaigns with a view to reducing this significant public health problem.

Complications of mammalian bites

The main complications of mammalian bites are tissue damage from the bite itself, infection and psychological distress.

Injuries sustained from a bite are dependent on the animal species and dentition, ferocity of attack and the anatomical location of the bite. Dog bite wounds are most often crush injuries, lacerations and abrasions resulting from the high pressures generated from the canine

jaw and the associated ripping and tearing motion.[12,13] In contrast, cats almost always inflict puncture wounds due to their long, slender incisor teeth. These wounds may appear minor at the skin surface but can penetrate deeply and puncture bone, joints and tendons. This is of particular importance on the hand, where joint penetration can easily be missed by clinicians.

The rate of infection of bite wounds differs between the animal species due to the oral flora in the biting animal and injury type. Infecting organisms most commonly arise from the mouth of the biting animal; however, they can also arise from the host's own flora or the environment. Animal bite infections should be considered to be polymicrobial, but certain unusual pathogens can be characteristic of particular animal species and knowledge of these is useful to guide antibiotic choice (*Table 1*). Australian antibiotic guideline recommendations for mammalian bites are shown in *Table 2*. Deep infection can result in septic arthritis, osteomyelitis, tenosynovitis and compartment syndrome.[12,14]

Psychological trauma following animal bites is an under appreciated problem. A study of 3000 people in Adelaide showed 50% of respondents feared dog attacks and 21% modified their behaviour toward dogs.[4] There is also evidence that of children who have experienced minor dog attacks, about half (50%) suffer post-traumatic stress disorder.[15]

Infectious risk according to species

Dog bites

Up to 18% of dog bites become infected, however, this increases when the hand is involved.[16–18] The microbiology of dog bite wounds is polymicrobial, with a mixture of aerobes and anaerobes. Of particular importance is the presence of species isolated in 50% of dog bite wounds.[17] Pasteurella species are the predominant organism in the oral flora of many animals, and is noteworthy because it produces a characteristic rapidly progressive skin and soft tissue infection and is generally resistant to flucloxacillin, first generation cephalosporins and clindamycin.[19] *Capnocytophaga canimorsus* is found in approximately 5% of dog bite wounds and may opportunistically invade the host, usually affecting immunosuppressed and asplenic patients (reports of severe sepsis in immunocompetent hosts had a case fatality rate of 28%[20]).

Methicillin resistant *Staphylococcus aureus* (MRSA) appears to be an emerging zoonotic pathogen. It is known that humans can transmit MRSA to their companion animals, however there are increasing reports of animal-

Table 1. Oral flora of mammalian species

Animal	Organism
Dogs[17,48]	*Pasteurella dagmatis, P. canis, Staphylococcus aureus, S. intermedius,* Streptococci, Moroxella spp., Neisseria spp., *C. canimorsus*, Clostridium spp. including *Clostridium tetani*, Anaerobes spp.
Cats[17,23]	*Pasteurella multocida*, mixed aerobes and anaerobes
Rodents[28-30]	*Streptobacillus moniliformis, Spirillum minus*, Salmonella spp.
Cows, horses, camels[9]	Polymicrobial, Actinobacillus spp.
Pigs[8]	Polymicrobial, Aeromonas spp., *P. aerogenes*, Actinobacillus spp.
Humans[16,42,43]	Viridans streptococci, *S. pyogenes, S. aureus*, Anaerobes, *Eikenella corrodens*, hepatitis B and C, HIV
Monkeys[33,49]	Mixed aerobes and anaerobes, Streptococci, Neisseria spp., *Haemophilus influenzae, Herpes simiae* (B virus)

Table 2. Australian antibiotic guideline recommendations for mammalian bite wounds[46]

Infection not established
• Amoxycillin + clavulanate (child: 22.5 + 3.2 mg/kg up to 875 + 125 mg) orally, 12 hourly for 5 days
• If commencement of above is likely to be delayed, procaine penicillin (child: 50 mg/kg up to 1.5 g) IM, as one dose followed by above
Infection established
• Metronidazole (child: 10 mg/kg up to 400 mg) orally, 12 hourly for 14 days
PLUS EITHER
• Cefotaxime (child: 50 mg/kg up to 1 g) IV daily for 14 days
OR
• Ceftriaxone (child: 50 mg/kg up to 1 g) IV daily for 14 days
ALTERNATIVELY USE
• Piperacillin + tazobactam (child: 100 + 12.5 mg/kg up to 4 + 0.5 g) IV, 8 hourly for 14 days
OR
• Ticarcillin + clavulanate (child: 50 + 1.7 mg/kg up to 3 + 0.1 g) IV, 6 hourly for 14 days
For patients with immediate penicillin hypersensitivity
• Metronidazole (child: 10 mg/kg up to 400 mg) orally, 12 hourly for 14 days
PLUS EITHER
• Doxycycline (child >8 years: 5 mg/kg up to 200 mg) orally for the first dose, then (child >8 years: 2.5 mg/kg up to 100 mg) orally, 12 hourly
OR
• Trimethoprim + sulphamethoxazole (child: 4 + 20 mg/kg up to 160 + 800 mg) orally, 12 hourly
OR
• Ciprofloxacin (child: 10 mg/kg up to +500 mg) orally, 12 hourly

to-human transmission in both domestic animals and livestock, and the emergence of new MRSA strains. Methicillin resistant *S. aureus* decolonisation of pets is recommended in the setting of recurrent infection of the human, if human household contacts are not colonised or already treated and the pet has been clearly identified as the source of recurrent infection.[21,22]

Cat bites

Twenty-eight to 80% of cat bites may become infected, with *P. multocida* isolated in 75% of cases.[23,24] *Bartonella henselae* (the causative organism of cat scratch disease) can be transmitted via the scratch or bite of an infected cat or cat flea, and 30% of Australian cats are bacteraemic with this organism.[25,26] In normal hosts, this is usually either asymptomatic or a self limiting lymphadenitis but can be a life threatening disseminated infection in an immunocompromised host.[25]

Rodent bites

Rodent bites have an infection rate of approximately 10%.[27] Rat bite fever is a disease caused by *Streptobacillus moniliformis* or *Sprillum minus* and should be considered in a case of systemic sepsis following a rodent bite.[28] Following an incubation period of 10 days to 4 weeks, the patient presents with fever, rash and septic arthritis.[29] The diagnosis requires a high index of suspicion as the organism is fastidious and good communication with the microbiology staff may help isolate the pathogen.[29,30] Treatment with penicillin or doxycycline is usually successful, however there are reports of serious complications such as endocarditis where mortality may be significant.[31,32]

Monkey bites

Monkey bites can present in returned travellers, zoo or laboratory workers. They pose a high risk of infection as well as serious damage to underlying structures.[33] Rabies can be transmitted from monkey bites. Prophylaxis should be offered for patients presenting with monkey bites sustained in a rabies endemic area, which recently has included Bali in Indonesia.[33,34]

Cercopithecine herpesvirus 1 (herpes simiae or B virus) infects old world macaque monkeys, can be transmitted by a bite or scratch[33,35] and human infection causes a fatal encephalitis if not treated appropriately. There is little data on the efficacy of postexposure prophylaxis; nonetheless expert opinion recommends 14 days of oral valacyclovir for moderate to high risk macaque monkey bites or scratches.[35,36] Referral to an infectious diseases specialist should be considered in these circumstances.

Bat bites

Australia is currently classified as being free of rabies, although a very similar virus, Australian bat lyssavirus (ABL) has been transmitted from bat bites on two occasions.[37,38] Both patients died from encephalitis and the second case was notable as the illness developed more than 2 years following the bat bite.[38] All bats in Australia can potentially transmit ABL, and considering the almost universal fatality rate of this disease, all bites should receive postexposure prophylaxis for rabies.[34,39] This should be given irrespective of the time lapsed since the bite. Furthermore, prophylaxis should also be offered to those where there has been a 'reasonable probability' of a bat bite occurring, such as children exposed to bats in confined setting. Bat bites can be tiny and may go unnoticed.[40]

Human bites

Human bites have a higher complication and infection rate than animal bites.[19] Most occur to the fingers, however 10–20% of wounds are 'love nips' to the breast and genitals.[19] If a bite mark has an intercanine distance greater than 3 cm, the bite probably came from an adult and this should raise concerns about child abuse.[41] Infected bites are usually polymicrobial, however the fastidious Gram negative *Eikenella corrodens* is well recognised as causing septic arthritis after a penetrating injury of the hand, and this may be complicated by infective endocarditis.

Hepatitis B and C can be transmitted by human bites[15] and human immunodeficiency virus (HIV) transmission has occurred on at least five occasions, mostly in the setting of bloody saliva and late stage HIV disease.[43] Although there is only limited evidence to support its use, HIV postexposure prophylaxis should be considered in high risk human bite injuries (ie. from a known HIV positive source).

Assessment and management of mammalian bites

The management of animal bites is an evidence poor area and most recommendations are based on small case series, microbiological data and expert opinion. The main controversies include whether wounds should or should not undergo primary closure and the use of prophylactic antimicrobials. The assessment and management of animal bites is presented in *Table 3*.

Most animal bite wounds can be managed in the general practice setting. However, it is important to recognise when a wound is at high risk of infection and when referral to hospital is required (*Table 4*). The following factors place wounds at a high risk of infection:[12,44–46]

- puncture and crush wounds (particularly if inflicted by a cat)
- wounds that penetrate bone, joint, tendons, vascular structures or that overly a prosthetic joint
- wounds on the hands, feet, face or genitals
- wounds with a delayed presentation of greater than 8 hours, and
- patients who are immunocompromised or have oedema or lymphoedema.

Prevention of bites

General practitioners play an important role in primary and secondary prevention of mammalian bites. They can provide opportunistic education for patients regarding behaviour around

Table 3. Assessment and management of mammalian bite wounds

Resuscitation[44]	• Treat any life threatening injuries according to standard guidelines • Children with facial or cranial bites need cervical immobilisation until cervical lesions are excluded
History[12,47,50]	• Circumstances of attack (animal species, provocation, timing) • Determine if law enforcement has been notified • Medical comorbidities (particularly immunosuppression) • Medications • Allergies • Immunisation status (tetanus, hepatitis, rabies) • Occupation • Hand dominance
Examination	• Exploration – even for apparently minor injuries • Document wound type and measurements • Identify foreign bodes (eg. animal teeth and debris) • Assess penetration of bone and joint (put joints through full range of motion) • Assess nerve, motor and vascular function (for bites in the hand or feet, placement of a proximal tourniquet may facilitate visualisation of deeper structures) • Assess for established infection (purulent/nonpurulent, abscess, extent, associated lymphadenopathy) • Draw diagrams and take photographs as necessary
Imaging[13]	• Identify foreign bodies (teeth), fractures and penetration of bone and joint • X-rays for all clenched fist injuries, puncture wounds near bone or joint and penetrating scalp injuries (a fracture associated with a bite should be managed as a compound fracture with hospital/specialist referral) • Ultrasonography can be used for diagnosis of suspected soft tissue injury
Important: determine if wound is at high risk of infection (see text and Table 4)	
Wound culture	• Only take cultures from clinically infected wounds • Communicate with microbiology staff that the specimen is from a bite wound
Wound management[11,12,50,51]	• Involves cleaning, irrigation and debridement • Wound should be cleaned with soap and water or normal saline as this reduces the concentration of bacterial contamination and may reduce the risk of infection (particularly in rabies bite) • Remove foreign bodies (dirt, debris, teeth) • If the wound is clinically infected, open sutures or incise and drain abscess • Irrigate the wound with copious quantities of normal saline or water. Use enough fluid to remove all visible dirt and foreign material (usually 250 mL is adequate) • Irrigate under high pressure using a 19 or 20 gauge needle or plastic catheter on a large syringe • Debride as necessary
Wound closure[52,53]	• Evidence is limited so assess on a case-by-case basis • Primary closure could be considered in carefully selected bite wounds where cosmesis is an issue • Primary closure of head and neck wounds with antibiotic prophylaxis is associated with low risk of infection (1%) due to enhanced blood supply and lack of dependent oedema • Suturing is not recommended in wounds at high risk of infection
Elevation/ immobilisation[50,54]	• Elevate the injured extremity during the first 48–72 hours • Significant hand wounds can benefit from 3–5 days of immobilisation in the position of function
Tetanus prophylaxis[34]	• Tetanus toxoid should be administered if 5 years since the last dose and the patient has completed a full primary course of tetanus immunisation • If the patient is unvaccinated, they should receive tetanus toxoid plus tetanus immunoglobulin
Australian bat lyssavirus/rabies prohylaxis[34]	• Rabies postexposure prophylaxis should be administered to all bat bites and returned travellers from a rabies endemic area with a mammalian bite wound • If the patient is unvaccinated, they should receive rabies immunoglobulin plus a full vaccination course with human rabies diploid cell vaccine. If the patient is vaccinated (documented), then rabies immunoglobulin is not required however they should receive two doses of rabies vaccination. Contact state public health authorities for advice and access to rabies vaccine

Table 3. Assessment and management of mammalian bite wounds (continued)

Postexposure prohylaxis: hepatitis B, C	• For human bites consider hepatitis B prophylaxis if not immune and HIV postexposure prophylaxis if at high risk (seek advice from infectious diseases physician)
Antibiotics[46,55,56]	• Prophylaxis: this is controversial considering side effects, cost and only marginal benefits demonstrated in meta-analyses of use in dog bites. Expert opinion recommends prophylaxis for high risk wounds only • Treatment of established infection: broad spectrum antibiotics should be used, covering aerobes and anaerobes, in particular Pasteurella spp. Pasteurella spp. should be considered resistant to flucloxacillin, first generation cephalosporins, erythromycin and clindamycin and these antibiotics should not be used alone for empirical treatment. This represents a common cause of treatment failure (See Table 2 for antibiotic recommendations)
Patient education[12,57]	• Written instructions upon discharge should include: – general wound care – daily wound inspection – emphasis of infection and other complications – specific signs and symptoms of infection or clinical deterioration – clear directions when and where to return for re-evaluation – importance of compliance
Patient review[12]	24–48 hours

Table 4. Indications for hospital referral[12,16,44,47,58]

Multiple and severe injuries
Systemic signs of infection
Cellulitis – severe or rapidly spreading or advancement past one joint
Involvement bone, joint, tendon or nerve
Refractory to oral antibiotic therapy
Wound requires surgical intervention (debridement, drainage, reconstruction)
Significant bites to the hand or cranial bites
Human bites with puncture wound
Immunocompromised host
Social reasons

dogs such as encouraging children to approach dogs cautiously with adult supervision, avoiding patting a dog that is eating or caring for puppies, not approaching a dog that is displaying territorial behaviour, and never leaving a child alone with dogs.[12] Doctors can ensure those who have contact with animals are up-to-date with immunisations, in particular selected travellers and those at risk of ABL exposure should receive rabies vaccination.[12,47]

Conclusion

Mammalian bites are common and potentially preventable. Permanent injury, infection and psychological trauma are frequent sequelae. Pets are an integral part of Australian culture and generate significant economic, social and psychological benefit to their owners. However, half the population will be attacked sometime during their lifetime, most often by a dog. Doctors need to be familiar with the assessment and management of bites and recognise when a wound is at high risk of infection and when referral to hospital is required.

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