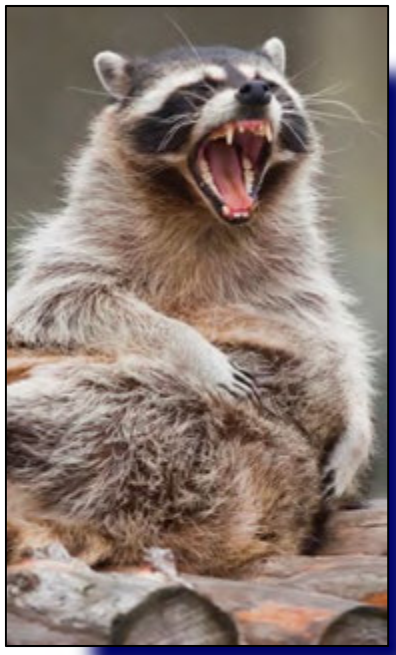
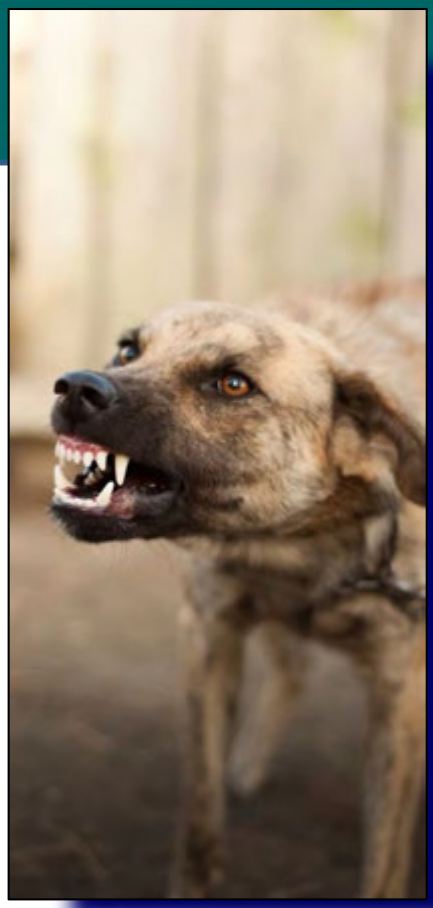
INVESTIGATION, MANAGEMENT, AND PREVENTION OF ANIMAL BITES IN CALIFORNIA

Third Edition





California Department of PublicHealth

Veterinary Public Health Section

DCDC Division of Communicable Disease Control

INVESTIGATION, MANAGEMENT, AND PREVENTION OF ANIMAL BITES IN CALIFORNIA

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Division of Communicable Disease Control
Center for Infectious Diseases
California Department of Public Health

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Contents

Preface

In 1973, the California Department of Health published *Guidelines for Investigation of Animal Bites*, in response to a request by the Environmental Health Committee of the California Conference of Local Health Officers. The document proved useful to a broad range of readers, and, in 1992, the California Department of Health Services published a revised edition as *Guidelines for the Treatment, Investigation, and Control of Animal Bites*. This document, *Investigation, Management, and Prevention of Animal Bites in California*, is the third edition prepared by the California Department of Public Health.

This handbook offers updated information on the causes, consequences, and prevention of animal bites and rabies. Because the overwhelming majority of reported animal bites are attributed to domestic dogs, investigation and prevention of dog bites are emphasized throughout; nevertheless, many of the fundamental principles discussed have application across a broad range of species.

As with the previous two editions, this publication is to be used as an information resource and guide. Local health departments are encouraged to adapt the principles described herein to best meet their needs within the resources available to them. *Investigation, Management, and Prevention of Animal Bites in California* is intended to serve as a complementary resource to other documents prepared by state and federal bodies, principal among these being *Human Rabies Prevention: Recommendations of the Advisory Committee on Immunization Practices*, and the compendia on rabies prevention and control prepared by the National Association of State Public Health Veterinarians and the California Department of Public Health. Additional information resources are referenced within and listed at the end of this document.

Information, procedures, and practices outlined in this document are intended to assist individuals and agencies in the investigation and prevention of animal bites in California. Except for statutes and regulations specifically cited, these recommendations are provided for informational purposes only and are not intended to be regulatory in effect.

Introduction

Animals provide numerous benefits to humans, and interaction with them can enhance both physical and psychological health. However, such interactions are not always benign or without adverse consequence. When threatened, many animals will bite as a defensive behavior. An animal may bite in response to fear or pain, in an attempt to assert dominance, or to protect its territory, food, and offspring.

Depending on the species and size of the biting animal, bites can result in wounds ranging from minimal to life-threatening. In addition to direct tissue damage, animal bites can introduce toxic chemicals and disease-causing microorganisms. Infectious consequences of bites range from mild, self-limited localized skin infection to severe, fatal systemic disease. The most notorious infectious disease associated with animal bites is rabies, which remains overwhelmingly fatal. As this disease presents the most concerning human health risk associated with animal bites, many of the established recommendations for prevention, treatment, and control of animal bites are designed to reduce rabies mortality. In addition to the adverse physical consequences, animal bites can be distressing to affected individuals and their community. Management and prevention of animal bites are best served by conducting thorough investigations of bite incidents and basing decisions and recommendations on the information gathered.

I. Epidemiology of Animal Bites

A. Surveillance

Reliable and comprehensive data for animal bites are difficult to tabulate as the majority of bites are likely minor, do not demand medical attention, and are never reported to health officials. In 1994, the U.S. Centers for Disease Control and Prevention (CDC) conducted the Injury Control and Risk Survey which estimated dog bite incidence in the United States at 18 per 1000 person-years [Sacks et al, 1996a]. A separate study estimated that each year in the U.S. two percent of the population—or approximately five million persons--experience a dog bite, resulting in 914 emergency department visits per day [Weiss 1998]. The 1992-1994 National Hospital Ambulatory Medical Care Survey estimated that 333,687 dog bite injuries are treated in emergency departments each year [Weiss 1998]. In 2011, over 50,000 animal bites (136 per 100,000 persons) were reported to local health departments and animal control agencies in California [http://www.cdph.ca.gov/HealthInfo/discond/Documents/Rabies/LRCA%20Reports/2011%20LRCA%20-%20Updated.pdf].

B. Factors associated with risk of animal bites

1. BITING ANIMAL SPECIES/BREED/CHARACTERISTICS

Throughout the world, domestic dogs are the vertebrate species most commonly reported to bite humans. Between 2006 and 2010, 77 percent of all animal bites reported in California were attributed to domestic dogs.

The contribution of a dog's breed toward its predisposition to bite remains uncertain. Epidemiologic studies that rely on bite reports or medical records often lack information on the baseline breed distribution in the owned dog community, leading to over-representation of the more popular breeds. Furthermore, because it is difficult to determine a dog's breed by purely physical characteristics, the recorded "breed" is most often a best guess based on a few recognizable features, many of which may be shared by several breeds. German Shepherd and Chow Chow were the breeds most frequently represented among surveys of dog bites [Gershman 1994, Patrick 1998]. In California, municipalities that adopt ordinances mandating spaying and neutering of certain dog breeds are required to report all dog bites to the California Department of Public Health (CDPH; California Health & Safety Code [HSC] §122331). Of these reports received in 2011, pit bull terrier (29%), German Shepherd or Shepherd mix (15%), and Chihuahua (11%) were the breeds most frequently reported as contributing to bite incidents.

Biting dogs are more likely than non-biting dogs to be male [Patrick 1998], sexually intact [Gershman 1994], less than 5 years old, and to weigh more than 50 pounds. Biting cats are typically stray or free-roaming females.

2. VICTIM CHARACTERISTICS

Bite victims are frequently children and adolescents. Incidence of dog bites in children ages 5 to 9 years is estimated as two- to three-times that in the general population [Harris 1974]. One study estimated that nearly half of all children have been bitten by a dog by the time they reach 12th grade [Beck and Jones 1985]. In California between 2006 and 2009, incidence of animal bites, as estimated by emergency department visits, was greatest in children 1 to 6 years old; incidence in adults was approximately half that of children and fairly uniform for all ages 14 years and older. Dog bite victims are more likely to be male and younger (<12 years old) than cat bite victims [Patrick 1998]. Newborns and infants are the most common victims of bite attacks from pet ferrets [Applegate 1998].

3. LOCATION

Most dog bites are inflicted by a known owned dog, at or near the dog's home [Harris 1974; Sacks et al. 1996b]. According to the American Veterinary Medical Association (AVMA), 36.5 percent of American households own at least one dog--approximately 70 million dogs nationwide. Adults with two or more dogs in the household are five times more likely to be bitten than those living without dogs at home [CDC http://www.cdc.gov/HomeandRecreationalSafety/Dog-Bites/biteprevention.html]. Cats are typically more independent and itinerant than dogs [Gershman 1994, Patrick 1998]. As such, cats are less likely than dogs to be either confined to the owner's property or under controlled restraint when off property.

Whereas roughly half of dog bites occur on the dog-owner's property versus in public areas (e.g., sidewalk, street, park), nearly 80 percent of cat bites occur off the owner's property.

Factors associated with increased risk of dog bites

Biting animal: Male, sexually intact, <5 years old
Bite victim: <10 years old, male
Bite location: On or near biting dog's home property
Bite provocation: Yes

4. PROVOCATION

Animal bites can be classified as provoked or unprovoked. Provoked bites are considered normal behavior and occur when the animal responds to a perceived threat to its body (fear-induced), food (possessive), territory, or offspring (protective). Approximately 50 percent of dog bites are classified as provoked, compared to nearly 90 percent of cat bites [Patrick 1998]. However, for the dog breeds most frequently reported in bite incidents (viz. Chow Chow, German Shepherd, pitbull terrier), 75 to 80 percent of these were classified as unprovoked. All reported ferret attacks on children appear to be unprovoked [Applegate 1998].

An animal's health may alter its threshold for provocation. Stimuli that would not be perceived as threatening by a healthy animal may precipitate a more aggressive response if the animal is ill, injured, or in pain.

Failure of a person to respond appropriately to a dog's social signals (see *BEHAVIOR* below) may also be considered provocation. Persons who fail to recognize canine social signals might unwittingly adopt a provocative posture which the dog interprets as a challenge. These behaviors include prolonged eye contact, a close and dominant stance (standing or bending over a dog), speaking in a low, gruff tone, or sudden, unexpected movement. Furthermore, provocation may extend beyond the place and time of the actual bite incident. A dog that is repeatedly grabbed or struck by a small child may come to anticipate these unwelcome actions and proactively strike the child upon entering the room—an action that, absent the previous history, would be considered unprovoked [Voith 1980].

5. BEHAVIOR

Dogs are gregarious animals and have evolved to live in groups ("packs") governed by a social hierarchy. A dog's behavior is influenced by its position in that hierarchy. Dogs interact with pack-mates through a language of signals that indicate roles and intentions. When a member of the pack—be it another dog or a human—misinterprets signals or attempts to redefine respective roles, the social equilibrium is disrupted, leading to more extreme reactions. Dogs indicate arousal and dominance through a combination of visual (e.g., ears forward, tail up), auditory (e.g., bark, growl), and olfactory (e.g., urine-marking) signals. If these signals fail to motivate the other dog--or person--to withdraw, the dog may attempt to control the situation through direct physical contact, i.e., bite. Dogs can also misinterpret apparently neutral behavior by humans as frightening or threatening: for example, the erratic movements and shrill squealing of small children could elicit protective or predatory aggression from a dog. Dogs often consider children to rank lower than adult humans in the pack and are more likely to challenge children's authority. Similarly, a dog may tolerate certain behaviors in children to a lesser degree than in adults, depending on how it perceives the relative positions of itself and the child in the "pack".

An unknown proportion of bites from pets represent true accidents, as inadvertent outcomes of play, hand-feeding, or other ordinarily benign interactions. Dogs with strong herding or misplaced maternal instincts may attempt to direct behavior or movement of children through nips or grab-and-guide. Misinterpretation of these encounters could precipitate a more aggressive response. A small proportion of animals suffer from inadequate social development, inborn behavioral problems, or neurologic disease that may cause the dog to react in an excessively aggressive manner to normally benign stimuli.

II. Animal Bite Investigation

A. Bite report

California regulation (17 California Code of Regulations [CCR] §2606) mandates that all bites from animals susceptible to rabies (viz. mammals) be reported to the local health officer.

> *Any person having knowledge of the whereabouts of an animal known to have or suspected of having rabies shall report the facts immediately to the local health officer. The health officer shall likewise be notified of any person or animal bitten by a rabid or suspected rabid animal.*
>
> *In those areas declared by the Director of the State Department of Health Services to be rabies areas (see Section 121585, California Health and Safety Code) the local health officer shall be notified when any person is bitten by an animal of a species subject to rabies, whether or not the animal is suspected of having rabies.* [The Director has declared all 58 counties in California as "rabies areas" every year since 1987.]

This initial bite report triggers the responsible public agency to initiate an investigation. While the authority to investigate a bite report and determine the disposition of the biting animal resides with the local health officer, he/she may delegate day-to-day responsibility to staff in one or more city, county, or non-governmental agencies, including departments of public health and environmental health, city or county law enforcement, and municipal animal control. Other groups that occasionally participate in animal bite investigations include private, not-for-profit humane societies, veterinary practitioners, wildlife rehabilitators, and the California state departments of Fish & Wildlife (CDFW), Food and Agriculture (CDFA), and Public Health (CDPH). It is critical that one agency assume lead responsibility to coordinate all efforts to ensure that animal bite investigations are properly triaged, that adequate and skilled resources are allocated, and that information is collected in a standard and comprehensive fashion. Animal bite investigations require trained field staff and knowledgeable supervisory personnel who can exercise a high degree of discretion in review and direction of field investigations.

The intensity and expedience with which bite report investigations are conducted will vary according to the circumstances of the given incident, assessed associated risks, and resources available to discharge these duties. Nevertheless, every investigation follows a standard set of fundamental objectives:

A) verify the accuracy of the initial report and collect additional information about the alleged bite incident(s);
B) determine the severity of potential consequences of the bite(s), principally the risk of rabies virus transmission;
C) assemble information to help guide appropriate medical care for the victim;
D) identify measures to reduce or eliminate the potential for additional bite incidents.

B. Initial Bite Investigation

The purpose of the initial bite investigation is to collect information upon which to render decisions regarding the disposition of the biting animal and medical management of the bite victim. The objectives of the initial investigation are (a) to obtain a detailed account of the bite incident and description of the biting animal, and b) to identify the implicated animal and evaluate its current health status. These objectives are best achieved by visiting the premises of both the biting animal and the bite victim to directly observe the former and interview the latter. If an agency judges that a bite incident presents a low risk of serious consequences—principally rabies transmission (See Section C below)—it may choose to conduct the investigation by telephone or mail. All parties should be contacted as soon as possible, ideally within 24 hours of receiving the report. In some instances, more than one call or visit will be necessary to obtain all the necessary information. A comprehensive information inventory would include:

Bite victim

1) Name
2) Residence street address
3) Age and sex
4) Telephone number
5) Date and time bitten
6) Geographic location where bite occurred
7) Anatomic location and extent of bite wound(s)
8) Description of biting animal
9) Narrative account of the bite incident
10) Names and contact information for other persons or animals known or suspected to have been bitten
12) Medical treatment received: first aid and/or professional care
13) Health care provider's name, address, and telephone number

Biting animal

1) Complete name, address, zip code, and telephone number of the owner of the biting animal
2) The name of any other person who will exercise control over or have authorized contact with the animal if it is placed in isolation (quarantine). Such persons could include a veterinarian, if the animal is to be isolated in a veterinary hospital, or an extended family member, if home quarantine is allowed at a private dwelling other than the animal's residence of record.
3) Species, breed, age, sex, and description of the biting animal.
4) Rabies vaccination history; date of vaccination, type and lot number of vaccine given and name of the vaccinating veterinarian. Vaccination history must be verified by original rabies vaccination certificates or veterinary clinic records. The description of the animal as stated on the vaccination certificate should be cross-checked to confirm that the certificate represents the implicated biting animal.
5) Dog license serial number, year of issue, and issuing agency.
6) Owner's statement regarding the circumstances of the bite. It should be noted, however, that the owner is frequently not the person who observed the bite incident. Independent testimonies from other knowledgeable witnesses should also be sought.
7) Health status of the biting animal. Ideally, all implicated biting animals should be examined by a licensed veterinarian. Practical constraints of the investigation, however, often limit the health assessment to the investigator's personal observation of the animal's current condition and the owner's testimony of the animal's recent health history.
8) Known, suspected, or possible contacts with other animals, including wildlife, at or away from home during the preceding six months
9) Adequacy of the owner's facilities to provide isolation of the animal for the required quarantine period, if home quarantine is being considered as an option
10) Owner's attitude toward, understanding of, and probable compliance with the conditions of home quarantine. Accurate appraisal of the owner's cooperation is critical toward whether home quarantine should be permitted

Any and all information collected during an animal bite investigation may be subject to subpoena if legal action is pursued. For this reason, investigators should take care to record information in a manner that is accurate, complete, consistent, and legible. (See Appendix A) Investigators should focus on recording objective observations, with photo documentation where possible, and not interject their personal opinion or interpretation of events. Investigators should also refrain from implicating culpability either in their interactions with involved parties or in written records of the investigation.

C. Rabies Assessment

Rabies is a serious, almost always fatal disease that should be considered as a potential consequence of any mammal bite. The bite incident investigator should endeavor to assemble all available information regarding the bite incident as efficiently as possible. These data comprise the basis upon which the risk of rabies transmission will be assessed. The responsible agency can then make an informed decision on the

disposition of the biting animal and offer appropriate recommendations to the victim for medical management of the bite. The rabies risk assessment should proceed in a standard and logical fashion.

1. *IS TRANSMISSION OF RABIES VIRUS POSSIBLE?*
A minimal set of specific factors must exist for rabies virus to be transmitted between an infected animal and a susceptible animal. Absent one or more of these factors, the possibility of rabies exposure can be dismissed.

a. *An infected mammal*

All mammals are susceptible to infection with rabies virus and capable of shedding and transmitting rabies. Moreover, only mammals pose a potential risk of rabies transmission. Rabies virus cannot be transmitted through bites, scratches, or other contact with birds, reptiles, amphibians, fish, or invertebrates.

b. *Virus-laden saliva*

In typical natural transmission, rabies virus is inoculated into subcutaneous or muscle tissue where it undergoes limited local replication. From there, rabies virus enters peripheral nerves and migrates up the nerve to the spinal cord. (Estimates of the speed of migration vary widely; figures from 8 to >400 mm/day have been reported.) Here the virus undergoes further replication and dissemination to other neurons throughout the central nervous system (CNS). Once in the brain, rabies virus spreads to the cerebellum, hippocampus, and medulla oblongata, but typically spares the cerebral cortex. Following additional replication in the brain, rabies virus spreads out to highly innervated tissues, particularly salivary glands. Rabies virus is present in the saliva of rabid animals from a few days prior to display of clinical signs, throughout the clinical illness, until the animal dies or is euthanized.

Fresh saliva is the only practical source of infection from a living rabid animal. Rabies virus is not present to any appreciable degree in a rabid animal's coat, skin, blood, urine, or feces. The rabies virus is inactivated by desiccation and ultraviolet radiation. If surfaces onto which saliva was previously deposited are now dry, they can be considered noninfectious. Contact with other potentially infectious material that is dry, such as brain tissue, does not constitute an exposure.

Nervous tissue from a rabid animal presents a theoretical but impractical risk of rabies transmission for most persons. Veterinarians, laboratorians, pathologists, and others who may have contact with nervous tissue from a rabid animal should adopt appropriate personal barrier protection. Secondary transmission of infectious nervous tissue--such as a cat that bites a rabid bat, has nervous tissue remaining in its mouth, then promptly bites another animal or person—constitutes a theoretical but implausible scenario for rabies transmission.

c. *Saliva contact with subdermal tissues or mucus membrane*

Rabies virus must be deposited on or near nerve endings for infection to occur. To reach nervous tissue, the virus must be introduced through a break that exposes subdermal tissues beneath the cutaneous barrier. This break in the skin can occur at the same time that infectious saliva is present—as in the classic bite from a rabid animal—or it may be a pre-existing cut, wound, or lesion on the skin onto which infectious saliva is subsequently deposited. Deposition of infectious saliva onto mucus membranes also represents a potential transmission route for rabies virus. In contrast, deposition of saliva onto intact, healthy skin would generally not be considered a potential rabies exposure.

Abrasions or scratches inflicted by the claws of an animal do not constitute a rabies exposure per se. Rabies transmission requires deposition of viable virus onto nerve endings which lie below the epidermis. Superficial scratches that do not penetrate the dermis and draw blood do not provide an avenue for rabies infection. Similarly, deep scratches for which subsequent deposition of fresh saliva can be ruled out do not represent possible rabies exposures. If injuries inflicted by an animal's nails are deep or extensive, and subdermal contamination with saliva is likely, the potential for rabies transmission should be considered.

Minimal requirements for considering the possibility of rabies virus transmission in a bite incident
1. A rabid mammal
2. Rabies virus in saliva
3. Saliva deposited beneath the skin or on mucous membranes

2. IS TRANSMISSION OF RABIES VIRUS LIKELY?

It is necessary to determine whether the biting animal was rabid or likely to be rabid only at the time the bite was inflicted. Information on the biting animal such as species, size, health, ownership (e.g., pet, feral, wild), and rabies vaccination history are essential for assessing the likelihood that it was shedding rabies virus at the time of the bite. The testimonies of the bite victim and other witnesses also provide helpful insight toward determining the need for rabies prophylaxis.

a. *Biting animal's species*

All mammals are susceptible to rabies; however, differences in physiology, behavior, or habitat affect the frequency with which members of a certain species are exposed to, infected with, and shed rabies virus. Surveillance data from detections of rabies in animals collected and submitted for testing provide only an approximate indication of which species are likely to be rabid. Because highly suspect species are preferentially routed for testing, surveillance data do not offer a representative sampling of all susceptible species. Furthermore, estimates of rabies prevalence among the wild population of a given species should not be inferred from surveillance data. Individual animals that are tested for rabies tend to be those for which a greater suspicion of rabies exists—e.g., normally nocturnal animals active during the day. The true prevalence of rabies in any species is likely several fold less than the prima facie prevalence estimated from surveillance data. For example, in one study [Davis et al 2012], rabies virus was detected in less than one percent of wild-caught, healthy Mexican free-tailed bats, compared to 92 percent of bats of the same species that were found on the ground.

1) High risk species

Bats, skunks, foxes, and wild cats are considered to carry the highest potential for rabies in California. These species constituted 98 percent of the nearly 10,000 rabid animals reported in California between 1983 and 2012. While no true reservoir for rabies has been identified, rabies viruses have evolved to be efficiently transmitted and maintained within certain species of mammals. In California, bat variant and skunk variant rabies viruses continually circulate in those respective animal groups. Wild canine and feline carnivores can acquire rabies through predation and consumption of rabid animals.

2) Medium risk species

Domestic animals, including pets (dogs, cats) and livestock (horses, cattle, sheep, goats), carry a lower degree of risk compared to the wild animals mentioned above. Domestic dog rabies remains the predominant contributor to rabies incidence throughout the world. However, the canine variant rabies virus was eradicated from the United States following the development and widespread use of an effective rabies vaccine for dogs in the mid-20th century. Because of the precipitous decline in rabid dogs, the incidence among other domestic animals, for which dogs were the primary source, has also decreased. Today, the infrequent case of rabies in a dog or other domestic animal in California occurs through contact with rabid wildlife, most commonly skunks and bats. Domestic animals may be exposed to rabies virus either by being bitten by a rabid wild animal or through predation/consumption, resulting in direct contact between oral mucous membranes and infected neural tissue.

Larger wild rodents (beavers, muskrats, marmots, and woodchucks) and wild omnivores (swine, bears) are capable of surviving attacks from a rabid animal and may live to develop rabies.

Perhaps owing to their lower body temperature, experimental evidence suggests that opossums may be both partially resistant to rabies and less prone to shed rabies virus in saliva [Beamer et al 1960]. Nevertheless, between 1922 and 2012, rabies was detected in 16 opossums in California.

3) Low risk species

Most rodents (gophers, chipmunks, squirrels, rats, mice), rabbits, and other small mammals (e.g., shrews, moles) are considered extremely low risk species. Bites from these animals rarely merit antirabies treatment. Such animals play a negligible role in the propagation of rabies in nature, probably because they fail to survive encounters with rabid carnivores. Because of these animals' very low risk for rabies, California regulations (17 CCR §2606(b)(3) and (4)) specifically exempt

rodents and lagomorphs from the isolation/observation and rabies testing required for all other mammals.

Although seals and sea lions are carnivores, they pose a negligible risk of rabies. Only one case of rabies has been reported in a pinniped—a ringed seal in Norway during an epidemic of rabies among arctic foxes [Ødegaard 1981].

b. *Biting animal's behavior*

Rabies virus migrates and replicates within the CNS, principally the brain. Impairment and destruction of brain tissue can lead to a variety of neurologic deficits, depending on which region(s) of the brain is affected. Abnormal behavior is the neurologic manifestation of rabies most obvious to the lay person. These abnormal behaviors can range from violent, unrelenting aggression in a normally docile animal, to an unresponsive stupor. Rabid animals often respond in an excessive, inappropriate, and aggressive manner to stimuli that present minimal or no threat. Rabid animals commonly attack inanimate or invisible objects. Behavior that is atypical for the animal's species can also indicate possible rabies. The most prominent feature of rabies in wild animals is the loss of normal fear of humans and normal avoidance of human habitation. Activity during the day by species normally active only at night or twilight (e.g., bats, raccoons), or in open, populated areas by normally shy and reclusive species (e.g., foxes) may indicate behavior changes suggestive of rabies. Nevertheless, the absence of overtly abnormal behavior should not be regarded as evidence that the animal is free from rabies. Neurologic deficits in a rabid animal may be inapparent, evident only upon close examination by a veterinarian.

c. *Biting animal's age*

Younger (juvenile) animals are considered to present a greater risk of rabies than older (adult) animals. Small, immature animals have less capacity to defend themselves against attacks by aggressive rabid animals. Also, because of their small size and naïve immune systems, a smaller amount of virus can lead to infection. On the other hand, extremely young animals (<2 weeks old) that bite are unlikely to have had sufficient opportunity to have been exposed to rabies virus, and for virus to replicate, migrate into the CNS, and spread to the salivary glands by the time of the bite incident.

d. Number, severity, location of bite(s)

The risk of rabies transmission is proportional to the amount of virus deposited in vulnerable sites. As such, multiple bites that compromise the cutaneous barrier expand the number of points of potential entry for the virus. Similarly, severe bites that expose large amounts of underlying tissue provide greater opportunity for rabies virus to be deposited on nervous tissue than mild, superficial bites. The closer to the CNS the virus is introduced, the shorter may be the incubation period from infected bite to disease. Bites to the face, head, neck, or spine represent a more exigent risk of rabies—and need for rabies prophylaxis—than do bites to the arms or legs. Finally, highly innervated tissues such as the hands and fingers provide a rich environment for rabies virus to invade and replicate. Nonetheless, it must be emphasized that <u>any</u> deposition of virus-laden saliva on mucous membranes or beneath the dermis constitutes a risk of rabies transmission.

e. Wound care

Immediate wound treatment is an indispensable component of bite management. Studies of rabies transmission in experimentally exposed animals have demonstrated that thorough wound cleansing alone markedly reduces the likelihood of rabies (Dean 1963, Kaplan 1962). Bite wounds for which liberal wound irrigation and vigorous scrubbing are difficult (e.g., puncture wounds), impossible (e.g., lacerations resulting in extensive tissue disruption), or delayed allow a greater amount of deposited rabies virus to remain in place and begin to replicate.

Relative indicators for rabies post-exposure prophylaxis (PEP)

Factor	Strong indicators	Weak indicators
Animal species	Bat, skunk, raccoon, unknown wildlife	Dog, cat, other domestic animal
Number of bites	Single or multiple	No bite
Bite location	More urgent: Face, head Less urgent: Extremities	
Bite severity	More urgent: Deep lacerations, considerable tissue damage; extensive bleeding Less urgent: minimal tissue damage or bleeding	Superficial; no bleeding
Medical attention	No or delayed wound care	Immediate cleansing and irrigation
Bite provoked?	No	Yes
Animal's health	Abnormal behavior	No obvious neurologic or behavioral abnormalities
Rabies vaccination	No documentation of rabies vaccination	Higher: Previous rabies vaccination but not current Lower: Current on rabies vaccination
Animal available for quarantine?	No	Yes
Animal available for testing?	No	Yes
Rabies recently detected in area wildlife?	Higher: Yes Lower: No	(Rabies should be considered possible in all parts of California, regardless of recent surveillance data.)
Victim's anxiety about rabies	(Objective scientific evidence should be the principal determinant for PEP decisions.)	Higher: High Lower: Low

f. Vaccination history

A biting animal that has a well-documented history of having received rabies vaccine, approved for use in that species and administered consistent with the labeled booster schedule, is unlikely to be infected with rabies virus. The Code of Federal Regulations (9 CFR §113.209) sets minimum standards for efficacy of veterinary rabies vaccines: at least 87-88% of test animals must survive challenge when they are inoculated with rabies virus one year after vaccination. Vaccines labeled for longer duration between boosters (e.g. three years) must demonstrate comparable efficacy for that longer period.

A history of having received rabies vaccination does not ensure absolute protection from infection. Individuals vary in both the magnitude and duration with which their immune systems produce protective antibody following vaccination. Also, rare inconsistencies in manufacture, storage, or handling can compromise a vaccine's potency prior to administration. Finally, errors in administration of the vaccine (e.g., intradermal rather than subcutaneous administration) can dilute the functional concentration of antigen below that necessary to support immunologic memory.

Nevertheless, failures of rabies vaccine efficacy are rare. Apparent break-through cases of rabies in vaccinated dogs occur in animals that are young (<12 months of age) and have received only one vaccine dose [Eng 1990]. Over a three-year period (2004-2007), the USDA Center for Veterinary Biologics investigated four cases of reported rabies in vaccinated dogs [Frana et al 2008]. A diagnosis of rabies could not be confirmed in two of these. One rabid dog was not vaccinated in accord with the label recommendations, resulting in a protracted period between the initial vaccine and booster. The second rabid dog had received a product from a lot which had been recalled due to questions of potency.

Rabies vaccines have been developed, tested, labeled, licensed, and marketed for a limited number of species: dogs, cats, horses, ferrets, cattle, and sheep. Wild and other domestic animal species may be vaccinated with one of these vaccines, but that vaccination is considered off-label and does not guarantee protection from rabies. Animals vaccinated with a vaccine labeled for another species must be considered unvaccinated if they are implicated in a bite incident.

g. Wildlife contact

The advent of effective rabies vaccines for domestic dogs in the mid-20th century, and institution of mandatory dog vaccination and registration regulations and ordinances, effectively eliminated an independent cycle of rabies transmission among domestic animals in California. As such, only domestic animals that have opportunity for contact with wild animals are at risk for contracting and shedding rabies virus. Domestic animals that are confined indoors or otherwise restricted from contact with wildlife have less opportunity for rabies than those that are housed outdoors or allowed to roam freely. Furthermore, rabies is more likely in domestic animals that have a known history of contact with wildlife, even if no specifically suspicious encounter is evident.

The already low risk posed by biting rats, mice, hamsters, rabbits, chinchilla, guinea pigs, and other small mammals kept as pets or for fur/food, can often be further diminished by consideration of where and how these animals were housed (vis á vis, opportunity for contact with wildlife) and how long they have been in the owner's possession. In the absence of contact with a rabid wild animal, the possibility of rabies can usually be excluded. Similar reasoning can help to guide assessments of bites from captive exotic animals in zoos, sanctuaries, and other facilities.

h. Rabies epizootiology

Animal rabies surveillance data can provide an inexact reflection of the biological, geographic, and temporal distribution of rabies transmission. A biting animal may be more likely to be rabid in an area where surveillance data indicate frequent or recent rabies detections in wild animals. Agencies responsible for animal bite investigations should maintain familiarity with the local rabies dynamics in their and neighboring jurisdictions to best triage bite reports for appropriate response. However, because of the idiosyncrasies of surveillance data, the converse does not necessarily hold: the absence of evidence for extensive or recent rabies activity does not preclude the possibility of ongoing transmission. Surveillance for any disease in wild animals is insensitive and highly dependent not simply on the incidence of the disease but the probability that an infected animal will come to the attention of reporting authorities. Animals that die of rabies away from populated areas, where their carcasses are less apt to be noted, retrieved, and tested, will not contribute to the surveillance data. Similarly, species that are small, reclusive, or likely to be readily consumed will less frequently be discovered by people. Terrestrial rabies—defined in California as skunk rabies—ascribes to relatively well-delineated regions—chiefly, the Sacramento Valley and regions north, the northern Sierra Nevada foothills, and the central and northern coasts [Crawford-Miksza 1999]. Non-terrestrial rabies circulates among bats, the various species of which are ubiquitous throughout California. As a result, all of California is considered endemic for rabies (See II A, above).

Because of the inherent insensitivity and deficiency of wildlife surveillance data, it is important to not give undue significance to individual data points but rather to consider larger patterns emergent from compounded data. For example, rabid bats have been reported from all 58 California counties, from below sea level to over 10,000 feet elevation in the Sierra Nevada Range. Detections of rabies in key wildlife species can fluctuate by season—e.g., approximately half of all rabid bats in California are reported between August and October. However, given the wide variability of incubation periods for

rabies in mammals, these seasonal patterns may not provide useful information toward inferring risk from a given suspect animal.

3. IS POST-EXPOSURE PROPHYLAXIS FOR RABIES INDICATED?

Although rabies is nearly always fatal, timely treatment of bite victims with approved anti-rabies biologicals, according to a protocol advocated by national authorities, is highly effective in preventing progression to clinical rabies. It is estimated that each year in the U.S. 10,000 to 30,000 persons undergo rabies post-exposure prophylaxis (PEP) following an animal bite [Johnston & Walden 1996]. It is impossible to identify those patients for whom PEP successfully averted rabies infection and those who were treated for only a potential exposure. While the high consequences of untreated rabies exposure tend toward liberality in PEP decisions, public health authorities and health care providers should strive to avoid recommending PEP to persons who have negligible or no risk of rabies exposure. Firstly, while highly effective in preventing rabies if administered prior to onset of clinical signs, rabies biologicals nonetheless share the innate risks of any exogenous pharmaceutical. Though rare, mild to serious adverse events may occur in some patients following administration of rabies immunoglobulin and/or vaccine. Secondly, widespread injudicious and indiscriminant use of biologicals could precipitate a shortage within the finite supplies of these products. Significant depletion of rabies biologicals from local inventories could compromise efficient PEP for patients with higher risk exposures. Finally, rabies biologicals and their administration entail significant costs which must be borne by the individual, his/her health insurance provider, public health agencies, or manufacturers.

The decision whether to initiate rabies PEP is grounded in the three following principles:

a. Objective assessment of rabies risk

Careful attention to collecting information relative to sections 1 (*Is transmission of rabies virus possible?*) and 2 (*Is transmission of rabies virus likely?*) above will provide the strongest foundation upon which to make an assessment of rabies risk. Nevertheless, this assessment will at best yield an indicator only of general relative risk (e.g., there is greater potential for transmission of rabies virus from an unprovoked skunk bite than from a provoked dog bite). Given the numerous factors involved in rabies transmission, it is not possible to calculate an absolute risk for rabies ascribed by a given set of circumstances. As such, strict consideration of objective variables cannot alone inform a purely deterministic decision on PEP. Moreover, an inflexible decision algorithm cannot account for input information that is missing, contradictory, or erroneous.

b. Subjective assessment of rabies risk

An important part of the PEP decision which should not be discounted is the bite victim's concern regarding the risk of rabies. Individuals will vary widely in their psychological response to an animal bite. These emotional responses can be independent of, and often contrary to, the level of risk estimated by objective criteria. Health care providers should consider their patient's anxiety as an ancillary factor when discussing and making decisions about rabies PEP.

c. Disposition of biting animal

Even if the risk of rabies transmission is judged to be high, in many cases PEP may be deferred for the short time required to collect additional information about the implicated animal. Many of the factors discussed in Sections 1 and 2 above attempt to imperfectly assess secondary evidence of rabies in the biting animal. If it can be ruled out definitively that the biting animal was shedding rabies virus at the time of the bite, the incident does not represent a possible rabies exposure and PEP is not necessary. Even if existing evidence indicates a reasonable likelihood of rabies exposure, initiation of PEP may yet be delayed if the biting animal can be unambiguously identified and placed under the control of proper officials for evaluation. The nature of that evaluation is determined by the level of risk objectively estimated in Sections 1 and 2 above.

D. Rabies risk-based response

1. HIGH OR ELEVATED RISK: EUTHANIZE AND TEST

If the risk of rabies transmission is deemed to be high, there may be an urgent need to verify whether the animal was shedding rabies virus at the time of the bite. There are no reliable methods for ante-mortem diagnosis of rabies. Although the principal concern in bite incidents is whether rabies virus was present in saliva, these secretions are not ideal specimens for testing because virus can be shed intermittently. Rabies infection is most quickly and reliably determined through examination of brain tissue removed from an animal shortly after it died or was euthanized. By California regulation (17 CCR §2606(b)(1) and (2)), the local health officer retains the authority to order the collection, euthanasia, and testing for rabies of any biting animal. Animal control authorities should verify any additional legal restrictions, through consultation with the California Department of Fish and Wildlife if necessary, to ensure compliance with existing statute and regulations before attempting to collect or euthanize a wild animal.

a. Collection/Capture and handling

The biting animal must be collected in a manner that does not pose undue risk of injury or harm to those collecting the animal, members of the public, or other animals. Capture should be conducted only by persons knowledgeable, trained, and skilled in methods appropriate to the species at hand. All persons charged with capture of a potentially rabid animal should have been pre-immunized against rabies. The number of persons deployed should be the minimum necessary to collect the animal. Domestic or wild animals collected for the purpose of rabies testing should be held for the minimum time necessary to arrange for euthanasia. During the holding period, access to the animal must be limited to the minimum number of authorized persons necessary to provide for its care.

b. Euthanasia

Euthanasia must be conducted in a humane and expeditious manner, using methods approved or recommended for use in the species in question [AVMA Guidelines 2013]. The choice of euthanasia method will depend on the species and size of the animal, the ease of handling, and the equipment and resources available to the controlling agency. Most inhalational and injectable euthanasia methods are acceptable for suspect rabid animals and will not compromise suitability of neural tissue for testing. Methods that require penetration of the skull and interruption of central brain function to effect death (e.g., gunshot) should be avoided as these may compromise brain tissue architecture and result in inconclusive results for rabies virus testing.

c. Testing

In California, testing of specimens from suspect rabid animals is performed at select county public health laboratories and at the CDPH Viral and Rickettsial Diseases Laboratory. Only Public Health Microbiologists working in these laboratories are trained and certified to conduct rabies testing according to established standards and accepted protocols. Specimens for rabies testing should not be submitted to commercial diagnostic or clinical laboratories. The public health laboratory should be contacted as soon as practical to alert them to the incoming specimens and to ensure that specimens are collected, packaged, and shipped in strict accordance with their protocol.

1) <u>Specimen collection</u>

i. Animal heads

Personal protective equipment such as plastic aprons, surgical gloves (disposable) and rubber gloves (heavy duty), and a safety face shield should be worn during the removal of the animal's head. The animal's head should be severed from the body at mid cervical vertebrae and placed in a leak-proof inner container. The inner container should be placed in an insulated outer shipping container and surrounded with sufficient coolant (commercial cold pack or dry ice) to preserve the tissue specimen during shipment. Because common liquid disinfectants, including undiluted bleach, inadequately decontaminate heavy suspensions of brain tissue, all instruments used in removing the head (pruning shears, necropsy knives, scissors) should be disinfected by steam or heat sterilization (autoclaves, instrument sterilizers, incineration).

ii. Brain tissue

While some public health rabies laboratories prefer to receive the intact head or the complete brain removed from the head, at a minimum complete cross-sections of brain stem and cerebellum should be submitted. Bilateral, complete cross-sections of the hippocampus may also be submitted for testing, if available. Failure to include these essential regions will result in a report of "Unsatisfactory," because rabies virus, while typically widespread in the brain of most rabid animals, may be sparsely and heterogeneously distributed in brain tissues. A definitive negative test result requires testing of complete cross-sections of the brain stem and either cerebellum or hippocampus. Each brain stem cross-section should be placed in a separate container labeled "Brain Stem;" cross-sections of cerebellum and bilateral hippocampus should be placed together in a second labeled container. Brain tissues must be kept cool, using cold packs or dry ice as described above. Do not place the brain tissue in formalin or glycerol saline.

2) Specimen submission

i. Routine

Cold pack refrigerants are satisfactory when the interval between packaging the specimen and receipt at the laboratory does not exceed 48 hours. For longer intervals, the specimen should be placed on dry ice. Fresh, refrigerated specimens are best. Submission forms and other specimen information should be enclosed in a properly addressed envelope and fastened to the outside of the mailing container. Submit specimens to the local public health laboratory by the fastest possible route, e.g., messenger or overnight courier service.

ii. Special circumstances

Occasionally, situations arise where, because of complete disruption of brain tissue (gunshot or other severe head trauma), identifiable brain tissue cannot be assembled for rabies examination. In these cases, attempts may be made to obtain salivary gland and/or spinal cord tissue for rabies testing by immunofluorescence (IF) examination or polymerase chain reaction (PCR). Examination of specimens in such cases should be done only after consulting with the laboratory to confirm that tests are feasible and to obtain specific instructions for packaging and delivery of these special specimen. The public health laboratory should be consulted also when formalin-fixed specimens are the only brain material available for testing.

3) Test procedures

The Direct Fluorescent Antibody test (DFA) may be performed only by an approved public health laboratory (17 CCR §2606(b)(4)). The DFA test for detection of rabies virus is rapid and reliable when performed by a laboratory following prescribed methods detailed in the CDC protocol "A Minimum Standard for Rabies Diagnosis in the United States" (http://www.cdc.gov/rabies/pdf/rabiesdfaspv2.pdf).

The public health laboratory will report DFA test results typically within 24-48 hours after it receives the specimen. A negative test result provides assurance that the animal in question was not infected with and capable of shedding rabies virus at the time of its death. If the local public health laboratory notes non-specific, irregular, or inconsistent staining, or any other factor that causes them to question the results, they should consult with the CDPH Viral and Rickettsial Diseases Laboratory for advice on confirmatory or alternative testing.

d. Reporting

The California Code of Regulations (17 CCR §2500, 2505) requires that detection of rabies virus in animal tissue and diagnosis of rabies in an animal be reported to the local health officer within 24 hours. Positive rabies test results are reported using the CDPH Animal Rabies Case Report Form (CDPH 102, http://www.cdph.ca.gov/pubsforms/forms/CtrldForms/cdph102.pdf). Section I of the form must be completed by the local public health agency and forwarded to CDPH as soon as possible. When the local public health agency has concluded its investigation of the rabies incident, Section II of the form should be completed and sent to CDPH.

e. <u>Disposal of Animal Carcasses</u>

Carcasses and other tissues from rabid animals are considered biohazardous waste and subject to restrictions on their disposal (HSC §117600ff; California Food and Agriculture Code §9141-9143). Incineration at a registered medical waste treatment facility is preferred. Alternative technologies that achieve a temperature of at least 1300 ^{o}F may also be acceptable but require pre-approval by the CDPH Medical Waste Management Program (HSC §118215(a)(1)(B)). Prior to transfer to the medical waste hauler, the carcass and any other tissues must be placed in a red biohazard bag and conspicuously labeled with the words "BIOHAZARDOUS WASTE." Each bag is securely tied and stored in a leak-proof container until retrieval by or transfer to the medical waste hauler. The California Department of Food and Agriculture should be consulted for disposal of animal carcasses whose size exceeds the capacity of the laboratory's contracted medical waste hauler (e.g., cattle, horses, sheep, etc.). Use of the carcass as food by any human being, domestic animal, or fowl is prohibited.

2. LOW OR MANAGEABLE RISK: ISOLATE AND OBSERVE

When the risk of rabies from a bite incident is judged to be low, a strict period of confined observation (quarantine) can offer an alternative to euthanasia and testing. There are no pathognomonic clinical indicators or reliable ante-mortem laboratory methods for determining if a suspect animal is rabid. Detection of rabies virus in nervous tissue requires sacrifice of the animal. However, the clinical course of rabies in selected species--particularly domestic dogs and cats--and its temporal association with shedding of virus in saliva has been well described as relatively consistent, of limited duration, and inevitably fatal.

a. Rabies quarantine

The fundamental principles of rabies quarantine are predicated on known and reliable estimates of the periods a) from pre-clinical shedding of virus to onset of clinically apparent neurological signs, and b) from onset of neurological disease to death in an infected animal.

In most rabid animals, rabies virus is shed in saliva only after onset of clinical signs. However, because the amount and distribution of rabies virus in the brain varies between infected animals, sufficient interruption of brain function to produce overt neurologic deficiencies may occur before, after, or at the same time that free rabies virus is found in saliva. Studies of animals experimentally inoculated with large doses of rabies virus directly into the jaw muscle have detected virus in saliva generally up to three days prior to onset of clinical signs in dogs [Vaughn et al. 1965] and up to one day prior to onset in cats [Vaughn et al 1963]. Moreover, less than half of rabid dogs shed virus in saliva at any time prior to death. One study of 39 dogs inoculated with either Mexican or Ethiopian dog-variant rabies virus detected virus in salivary glands in 16 (41%) dogs [Fekadu et al 1982].

Although an infected animal can have rabies virus in saliva prior to showing clinical signs, no species enjoys a true "healthy carrier state" where an infected animal remains asymptomatic but infectious for an indefinite or extended period of time. Rabies virus cannot appear in saliva prior to, or in the absence of, replication of virus in the CNS, and neurologic signs will invariably ensue in any infected animal. Furthermore, rabies is a universally fatal disease in domestic animals. Onset of clinical signs of rabies proceeds inevitably to death within a matter of days. One case series of naturally infected animals reported that 81 percent of rabid dogs and 72 percent of rabid cats died within three days of being placed under observation [Tepsumethanon et al 2004]. The maximum time to death was nine days, which was observed in less than one percent of rabid animals.

Earliest period (days) prior to onset of clinical signs and prior to death in which rabies virus was present in saliva of some mammals

Species	Prior to onset	Prior to death	Reference
Domestic dogs	7	12	Vaughn 1965
	7	12	Fekadu 1982[a]
Domestic cats	1	6	Vaughn 1963
Ferrets	2	Undetermined[b]	Niezgoda 1998
Mexican freetail bats	12	18	Baer 1967
Striped skunks	5	9	Sikes 1962
Gray, red foxes	Not reported	3	Sikes 1962
Other species	Unknown	Unknown	

[a]A single dog in this study that was inoculated with an Ethiopian canine strain of rabies virus had an excessively long shedding period of 13 days prior to onset and 14 days prior to death.

[b]All study ferrets were euthanized after onset of clinical signs.

Because a rabid dog or cat will predictably die within a known period of time, suspicion of rabies can be eliminated if the dog or cat remains healthy and alive 10 or more days after a bite incident. It is important to recognize that the dog or cat may yet be infected with and incubating rabies, but we can be confident that it was not shedding virus at the time of a bite inflicted 10 or more days earlier.

California law permits the local health officer to order biting animals of other species to be isolated and quarantined for at least 14 days. However, as the pre-clinical shedding period and time course from clinical onset to death are undefined for animals other than domestic dogs, domestic cats, and ferrets, quarantine of other species involved in a bite incident is discouraged and should be undertaken only under limited circumstances in which the likelihood of rabies is judged to be low.

1) Quarantine Order

The quarantine order (See Appendix B) is a legal document prepared by the local rabies control authority and delivered to the owner or party responsible for the biting animal. The quarantine order should include: the name and address of the responsible party, name and description of the animal to be quarantined, the inclusive dates for quarantine, and the place of quarantine. The animal to be quarantined should be identified and described as unequivocally as possible, including indicating license tag number, describing distinguishing markings, or attaching a photograph. The quarantine order should cite the authorizing state statute and/or local ordinance for quarantine and delineate the conditions of quarantine. The order should acknowledge the authority of the local health officer to at any time order the destruction of the biting animal for the purpose of performing laboratory examination for rabies. Both the issuing rabies control officer and the responsible party should sign and date the order. Concealing the location of a biting animal or violating any clause of a quarantine order is a misdemeanor under California state law (HSC §121705, 121710), punishable by fine and/or imprisonment.

2) Place of quarantine

The California Code of Regulations (17 CCR 2606(b)(2) and (3)) grants the local health officer the authority and obligation to determine the place and manner under which rabies quarantine is to be

conducted. The place of quarantine should be chosen so as to maximally fulfill the two fundamental objectives of rabies quarantine:

1) to place the animal under scrupulous, continuous observation so that any incipient signs of rabies are readily detected;

2) to isolate the biting animal from the community and eliminate the opportunity for additional exposures.

i. Away from home

Veterinary hospitals, animal shelters, kennels, or similar facilities are the preferred environments for isolating and observing animals subject to a bite quarantine order. These facilities offer secure individual housing in which the animal can be isolated from other animals and restricted in its contact with people. Trained staff are aware of the objectives of quarantine and professionally responsible for ensuring that the conditions of the quarantine order are upheld. Also, knowledgeable veterinary and allied personnel are skilled to monitor and to recognize possibly subtle neurologic signs that could indicate the onset of clinical rabies.

Facilities should ensure that the quarantined animal is housed individually, in an enclosure that does not permit contact with other animals. The animal enclosure should be in a location inaccessible by the public. Signs indicating that the animal is currently under rabies quarantine should be posted prominently on the entrance to the enclosure. Interaction with the animal should be restricted to the fewest experienced and responsible staff necessary for its feeding and care.

ii. At home

Quarantine at an animal shelter or other professionally staffed premises is the ideal for all biting dogs and cats. However, if the bite investigation yields information to indicate that the animal poses a low or manageable risk of rabies, alternative quarantine arrangements are acceptable. Under some local animal control ordinances, biting animals may be quarantined in the owner's home or other residence. As these private locations provide a less secure environment, home quarantine should be considered only when the risk of rabies is assessed to be low, e.g., a currently vaccinated animal in apparent good health which was determined to have been provoked to bite. Whenever a home quarantine is instituted, the owner or responsible party should sign the quarantine order affirming that he/she will quarantine the animal in a secure location, report immediately to the investigating agency any signs of illness or abnormal behavior that may develop, and assume all liability for the quarantine (including patient medical care if additional exposures occur during quarantine). A "secure location" is defined as being inside the owner's home or in a well fenced-in area outdoors. The area in which the animal is enclosed should preclude contact with other pets in the home, other people and pets in the neighborhood or community, and wild animals. Persons who have contact with the animal should be limited to the minimum number (ideally 1) of responsible adults necessary to tend to the feeding and care of the animal during quarantine. At no time should the animal be removed from the quarantine area without first notifying and receiving permission and instructions from the local rabies control authority.

Ideal factors for permitting home rabies quarantine

1. Domestic dog or cat
2. Written documentation of at least primary and first booster rabies vaccinations
3. Currently healthy; no signs of illness
4. Adequate indoor facilities to confine the animal
5. Ability to effectively exclude children and others from quarantine area

The agency overseeing the quarantine should have confidence in the ability, responsibility, and cooperation of the owner to comply with the conditions of quarantine before permitting home quarantine. Additional instructions and restrictions may be necessary to permit at-home quarantine in households with children or other residents who lack the mental maturity to appreciate and abide by the strictures of quarantine. The agency should also have adequate resources to verify compliance

with the conditions of quarantine, e.g., unannounced inspections. If evidence of non-compliance with the conditions of at-home quarantine emerges, it may be necessary to remove the animal and quarantine it in a veterinary hospital, animal shelter, or other off premises facility at the owner's expense.

3) Health monitoring

Throughout the rabies quarantine, the animal should be continuously monitored for any indications of changes in its health. A high index of suspicion should be maintained and any apparent changes in the animal's health or behavior should prompt an evaluation by a veterinarian. Under California regulation (17 CCR §2606(b)(2)), only a veterinarian may render clinical judgment on the health status of an animal under rabies quarantine. Local rabies control agencies that do not have a veterinarian on staff should establish a contract with a local veterinary practice to provide services for examination and evaluation of animals under rabies quarantine.

The initial signs of rabies can be variable, insidious, and non-specific. While observations of large numbers of rabid animals have yielded composite descriptions of typical rabies for some domestic species, there can be considerable variability in the number, severity, and sequence of signs across individuals of a given species. The initial signs of rabies in nearly all animals are more likely to be subtle, sporadic alterations in behavior or temperament than overt neuromuscular dysfunction. For some rabid animals, the first and only sign is sudden death. Observation of any of the following signs in an animal under rabies quarantine should prompt an immediate evaluation by the veterinarian.

Clinical signs of rabies in domestic animals

a. Withdrawal from and resistance to contact; seeking seclusion
b. Wide-eyed; reduced frequency or absence of blinking; dilated pupils; photophobia.
c. Exaggerated, often aggressive, response to tactile, visual, or auditory stimuli
d. Snapping/biting at imaginary objects
e. Pica (eating or mouthing sticks, stones, soil, clothing, feces, etc.)
f. Aggressively attacking inanimate objects
g. Sexual excitement with attempts to mount inanimate objects
h. Compulsive running or circling, often to the point of exhaustion
i. Obsessive licking, biting, or scratching at the site of viral inoculation
j. Dropped jaw, inability to swallow, excessive salivation
k. Change in tone, timbre, frequency, or volume of vocalizations
l. Flaccid or deviated tail / penis
m. Tenesmus (due to paralysis of the anal sphincter)
n. Muscular tremors
o. Acute onset of mono-, para-, or quadri-paresis; lameness
p. Abnormal, exaggerated gait; ataxia and incoordination
q. Convulsive seizures
r. Paralysis, prostration, recumbency
s. Death

If after examining the animal the veterinarian determines that these, or any other signs of illness, are suggestive of rabies, the agency overseeing the quarantine should immediately take custody of the animal (if an on-premises quarantine), safely and humanely euthanize it, and remove and submit the brain to the designated public health laboratory for testing.

4) Release from quarantine

At the end of the quarantine period, a representative of the agency overseeing the quarantine—ideally, a veterinarian—should examine the animal to confirm that it remains healthy and free of any clinical signs suggestive of rabies. If the animal is healthy, rabies exposure at the time of the bite incident has been ruled out and the animal may be released from quarantine. For animals quarantined at home, a visit and visual verification by a representative of the agency overseeing quarantine is recommended, but verbal confirmation of the animal's health by the owner may be adequate for very low risk animals. An animal may not be released from quarantine except by authority of the local

health officer (17 CCR §2606(b)(1)). If the quarantined animal is not currently vaccinated against rabies, a rabies vaccine should be administered prior to release from quarantine. All persons who were bitten or had concerning contact with the animal should be informed that the animal is healthy and there is no possibility of rabies virus transmission.

III. MANAGEMENT OF ANIMAL BITE WOUNDS

A. Medical Consequences of Animal Bites

1. PRIMARY BITE TRAUMA AND SEVERITY

Most (est. 80%) animal bites cause no or only minor injury, which can be adequately managed in the home with cleansing and first aid [Cornelissen 2010; Goldstein 1992]. However, of the nearly five million dog bites sustained in the U.S. each year, approximately 800,000 dog bite victims seek medical attention for their injuries [Sacks 1996a]. From 2006 to 2009, 144,926 emergency department visits for animal bites were recorded in California. The median charge for an emergency department visit for a dog bite in a child was estimated at $300; estimated medical charges increased to $3600 for 23-hour observations and $5900 for hospitalizations [Daniels 2009]. Approximately one-third of bite-related medical visits were covered by private insurance.

Several factors can contribute to the severity of the bite wound(s) and need for medical attention:

a. *Species of animal*

Of nearly 145,000 bite wounds treated at emergency departments in California between 2006 and 2009, 80 percent were attributed to dogs. Canine teeth create cutting and crushing damage to tissues, in contrast to the needle-like dentition of cats that typically leave discrete puncture wounds. Bites to the head and face are more frequently sustained from dogs and ferrets [Constantine 1986, Ferrant 2008]; of 6300 emergency department visits for bite-related wounds to the head or face in North Carolina, 94.6 percent were associated with dog bites [Rhea 2014]. In one survey of ferret bite incidents, which occasionally represented dozens to hundreds of laceration wounds, 28 percent of infant victims required plastic and reconstructive surgery [CDHS 1988].

Bites from aquatic animals can also cause significant tissue damage. Bites of a barracuda, a fish with sharp teeth, lead to shearing injuries, whereas eel bites cause severe lacerations and deep puncture wounds. While bites from sharks are often sensationalized, most result in fairly minor injuries such as puncture wounds and linear lacerations. Rarely, shark bites can cause large (>20 cm) lacerations, significant tissue damage, loss of limbs, or death—the last most commonly from exsanguinating hemorrhage [Woolgar 2001]. Ninety-five percent of shark attacks recorded in California waters between 1950 and 2011 were attributed to great white sharks [Florida Museum of Natural History], which typically inflict long, deep lacerations [Woolgar 2001].

b. Bite force

Size, skull shape, dentition, and jaw musculature all contribute to the force with which an animal can bite. Bite force has been directly measured in only a few species. Mean bite force in dogs ranged from 442 N for dogs weighing more than 34 kg, to 52 N for dogs weighing less than 11 kg [Linder 1995]. In comparison, the bite force of a domestic cat was estimated at 56N [Wroe 2005]. Among terrestrial mammals studied, estimated bite forces was greatest for tigers (1525N) and African lions (1768N). The greatest bite force calculated among all animals is nearly 6000N by an adult bull shark [Habegger 2012].

c. Age/size of victim

Children are more likely than teenagers and adults to sustain bite injuries that require medical attention. In 2001, approximately 370,000 emergency department visits were recorded in the U.S. for dog bite-related injuries; 42 percent of these patients were children ≤14 years old [CDC 2003]. Similarly, children ≤14 years old comprised 30 percent of bite-related emergency department visits in North Carolina from 2008 to 2010 [Rhea 2014]. In 1992-94, the incidence of emergency department visits for dog bites was highest for boys aged 5 to 9 years; dog bite injuries represented 3.6% of all emergency department injuries for this age/sex group [Weiss 1998]. Also, because of their smaller stature, children are more likely to suffer bites to the head and face [Lang 2005; Harris 1974; Daniels 2009]. Injuries to the head and face represented nearly two-thirds of bite injuries among children aged <4 years in one study [CDC 2003] and nearly three-quarters of bite injuries among children aged 0 to 9 years in another [Weiss 1998].

d. *Number of animals*
Most animal bites victims are bitten by only a single animal. Unusual circumstances such as persons attempting to intervene in a fight between two or more dogs might increase their vulnerability to bites from multiple animals. Furthermore, because the communication cues operational between dogs during normal circumstances are often ignored during a fight, animals may persist in frenzied biting behavior and inflict more bites per animal than would occur in an altercation between a single dog and the human victim. Of 238 dog bite-related fatalities identified between 1979 and 1998, 78 (33%) involved 2 or more dogs [Sacks 2000].

e. Behavior
Failure to recognize and appropriately respond to early signs of fear or aggression in a dog can lead to both the initial and sustained attack. A fearful or aggressive dog is unlikely to back down if its initial aggressive threats are challenged with reflected aggression. A person who responds to canine aggression in a dominant, violent, and loud manner, rather than assuming a calm and submissive posture, is more likely to sustain multiple wounds as the dog persists in its attack.

2. SECONDARY COMPLICATIONS AND ADVERSE HEALTH EVENTS

In addition to the acute trauma inflicted by an animal bite, the compromised and damaged tissue can lead to localized or systemic infection, disability, and disfigurement. Even apparently minor bites that directly cause negligible tissue damage can develop serious, possibly fatal, infection. Potentially pathogenic bacteria have been recovered from approximately 85% of fresh bite wounds; up to 30% of bite wounds progress to frank infection [Goldstein 1989; Goldstein 1992]. According to the American Society of Plastic Surgeons statistical data, nearly 30,000 reconstructive procedures were performed for dog bite injuries in 2011 [http://www.plasticsurgery.org/News-and-Resources/2011-Statistics-.html]. Moreover, the long-term psychological impact that follows disfiguring bite injuries, particularly to the face, is difficult to quantify.

A small percentage of bite incidents result directly or indirectly in the death of the bite victim. An average of 12 people die each year in the U.S. from dog bite-related injuries [AVMA https://www.avma.org/News/PressRoom/Pages/Dog-Bite-Fact-Sheet.aspx].

Factors associated with bite wound complications include:

a. *Species of animal*
Wound infections are more frequently observed in bites from cats (28% to 80%) than from dogs (3% to 18%) [Douglas 1975; Rhea 2014]. The deep puncture wounds resulting from cat bites are superficially less severe than the typical crushing wounds from dog bites, but are also less amenable to thorough cleansing, irrigation, and debridement, rendering them more vulnerable to infection. The period from infliction of the bite to the first symptoms of infection is shorter (7-18 hours) for cat bites compared to dog bites (12 -48 hours) [Talan 1999]. Cat bites are also more frequently associated with severe systemic sequelae, such as meningitis, osteomyelitis, endocarditis, septic arthritis, and septic shock. In one case review, 30 percent of patients bitten on the hand by a cat were hospitalized [Babovic 2014].

Besides dogs and cats, reptile bites can lead to complications. Native to California are six species of rattlesnake and one species of lizard (Gila monster) that produce hemotoxic, neurotoxic, or proteolytic venom. In addition to profound pain and disability, these venoms can cause extensive tissue damage and, in extreme cases, necrosis and loss of digits or limbs.

b. Tissue trauma
Dog bites that create dead space—whether from lacerations or puncture wounds--were nearly three times as likely to be infected (32%) as similar wounds that did not create dead space (11%) [Myers 2008].

c. Anatomic location
Bites to the hands are particularly susceptible to infection due to the proximity to the skin of underlying bones, joints, and tendons [Smith 2000, Brook 1989, Thomas 2011]. In one study of patients bitten by a cat on the hand or wrist, patients who were bitten over joints or tendon sheaths were nearly three times as likely to be hospitalized as those bitten on soft tissue [Babovic 2014]. Bites over or near a joint can lead to osteomyelitis and septic arthritis. Bites to the cranium may result in infections or abscesses in the brain or supporting structures. Wounds and resultant scars to the face are more likely to be considered "disfiguring" than similar wounds to the trunk or extremities.

d. Health of bite victim
As with nearly any acute health incident, animal bites are more likely to precipitate significant complications and sequelae in victims who have pre-existing conditions that compromise their ability to respond to injury. Persons who are elderly, immunosuppressed, have sub-optimal hepatic or splenic function, or suffer from chronic conditions such as diabetes or cardiovascular disease may be more susceptible to infection and other secondary complications of animal bites. Furthermore, these pre-existing conditions may complicate the therapeutic options available to treat the sequelae.

e. Timeliness and appropriateness of medical attention
Immediate wound care can significantly reduce the possibility for secondary infection, loss of devitalized tissue, and irreparable disfigurement. Bite victims who have grossly severe and serious wounds are more likely to seek emergency medical attention (< 12 hours after incident). Persons who delay seeking medical attention until later (>12 hours after incident) are more likely to already be experiencing symptoms and signs of infection or neuromuscular damage, often from grossly less significant wounds.

3. INFECTION

The chief medical concern of animal bites is infection. Bite wounds compromise the normal barrier between the outer protective epidermis and the deeper, normally sterile subcutaneous tissues. This entryway for microbial inoculation can persist for days to weeks following the bite incident. Studies have identified contamination with potentially pathogenic bacteria in >85 percent of fresh bite wounds, however only 15-20 percent of bite wounds develop frank infection [Goldstein 1992].

a. *Bacterial infection*

A wide range of bacteria from the biting animal's mouth, the victim's skin, and the surrounding environment can infect a bite wound. The number of different bacteria isolated from dog bite wounds has been reported to range from 1 to 4 in nonpurulent wounds, and up to 16 in purulent and abscessed wounds [Abrahamian 2011].

Over 130 species of bacteria have been recovered from dog and cat bite wounds [Talan 1999]. *Pasteurella* spp. are the most common microbial isolates from infected bites, occurring in more than 75 percent of cat bites (*P. multocida* ssp *multocida* and ssp *septica*) and approximately 50 percent of dog bites (*P. canis*) [Talan 1999]. Symptoms of infection—typically cellulitis--develop rapidly, often within 24 hours. Abscess formation, osteomyelitis, septic arthritis, endocarditis, meningitis, and sepsis are possible [Goldstein 1989; Luchansky 2003].

Staphylococcus, *Streptococcus*, *Enterococcus*, and *Neisseria* are the bacteria most commonly isolated from horse, pig, and primate bite wounds [Brook 2009]. Bacterial pathogens commonly found in the oral cavity of terrestrial reptiles include *Pseudomonas aeruginosa*, *Proteus* spp., coagulase-negative staphylococci, *Salmonella* groups IIa and IIIb, and *Clostridium* spp. Bites from fish and aquatic reptiles are infected most frequently with *Vibrio* and *Aeromonas* spp. Infection with *Mycoplasma phocacerebrale* following bites or other contact with seals/sea lions can cause severe, painful swelling without abscess or other signs of infection [White 2009].

Anaerobic bacteria, most commonly gram-negative bacilli, are recovered from up to 75% of infected dog and cat bite wounds [Brook 1987; Talan 1999]. The isolated strains are most frequently *Porphyromonas* spp., and less frequently *Fusobacterium*, *Bacteroides*, and *Prevotella* [Brook 2009].

Bartonella henselae is the causative agent of cat scratch disease, which can follow a bite or scratch from a cat. Cat scratch disease most commonly manifests as regional lymphadenitis, but systemic infections, including osteomyelitis and encephalopathy, can occur, particularly in immunocompromised individuals. *B. henselae* does not cause obvious illness in cats, and up to half of domestic cats carry the organism at some point in their lives, usually as kittens.

Tetanus, caused by *Clostridium tetani,* is a concern for contamination of any wound, including animal bites. Patients who have had a primary series of three previous immunizations with tetanus toxoid (Td) or tetanus-diphtheria-acellular pertussis (Tdap) vaccine, with the last dose or the last booster within the last five years, are protected against tetanus and do not require a tetanus toxoid-containing vaccine. Patients who have completed the three-dose series but the last vaccine or booster was >5 years ago should receive a booster dose. Patients whose primary tetanus immunization history is unknown or incomplete should receive the full three-dose primary tetanus vaccination series. Finally, patients whose primary tetanus immunization history is unknown or incomplete, and whose wound is particularly large, penetrates into muscle, is dirty, or results in visible devitalized tissue, should receive tetanus immune globulin (TIG), in addition to the three-dose primary series [CDC 2006].

Capnocytophaga canimorsus is part of the normal canine oral flora. *C. canimorsus* is rarely isolated directly from bite wounds—likely partly a consequence of its fastidious growth requirements--but can contribute to severe systemic infections, including sepsis, septic arthritis, meningitis, endocarditis, renal failure, and disseminated intravascular coagulopathy [Lion et al 1996]. Cutaneous manifestations are common, including maculopapular, petechial, or ecchymotic rashes. Cellulitis, necrotizing eschar, and gangrene can require amputation of digits or limbs. Up to a third of infections may be fatal despite the organism's susceptibility to penicillins, fluoroquinolones, and cephalosporins. Liver disease, asplenism, immunocompromising disease or pharmacotherapy, and advanced age are apparent risk factors for *C. canimorsus* systemic infection. Of 19 patients from whom isolates of *C. canimorsus* were forwarded to the CDPH Microbial Disease Laboratory between 2002 and 2011, the median age was 62 years (range, 23 to 85 years) and four reported a history of dog bite.

Rodent bites can also lead to bacterial infection. It is estimated that 20,000 persons are bitten by rodents each year in the U.S. [Abrahamian 2011]. *Streptobacillus moniliformis* (less commonly *Spirillum minus*) is the cause of rat bite fever--an acute illness characterized by fever, chills, myalgia, recurrent arthralgia/arthritis, and maculopapular rash. Severe manifestations include endocarditis, meningitis, sepsis, and death in up to 10 percent of untreated patients. Rat bite fever is rare and most commonly associated with bites from laboratory or pet rats. Feline, canine, and other carnivore predators of rodents may be transiently infected and transmit the organism through bites.

b. *Viral infection*

Compared to bacterial infections, viral complications of bite wounds are rare. Rabies is the chief viral pathogen of concern in bites from a mammal, but other viruses can be transmitted in bites from selected species.

Lymphocytic choriomeningitis virus is found in numerous rodents, most commonly house mice, and transmitted to humans through direct contact, infected aerosols, or bites. Infected rodents are asymptomatic, but in humans the virus causes fever, headache, myalgia, and in rare instances meningitis or meningoencephalitis.

Cercopithecine herpesvirus 1, also known as B virus or *Herpesvirus simiae*, is a herpes virus enzootic in Old World monkeys including Rhesus, Cynomolgus, and other Asiatic macaques. The prevalence of infection is low among immature macaques, but approaches 90 percent or higher among sexually active adults [Holmes 1995].

Humans who have direct contact with monkeys can be infected with B virus. Bites and scratches are most common, but other contact with tissues and secretions can effect transmission. Infected persons first experience vesicular lesions and abnormal sensation at the bite site, as well as fever, headache, and fatigue, 1-3 weeks after the incident. More severe systemic symptoms such as lymphadenitis, nausea

and vomiting, and abdominal pain can also develop. Spread of the virus to the central nervous system leads to increased sensitivity to stimuli, uncoordinated movements, double vision, agitation, and ascending flaccid paralysis—the last frequently contributing to fatal respiratory paralysis.

Human illness due to B virus is rare. Despite many persons with frequent, close contact with macaque monkeys in the decades since the virus was first described in 1932, only approximately 30 well-documented cases of human infection have been reported. It is estimated that only 0.04 to 2.0 percent of contacts with macaques have the potential to result in exposure to material contaminated with B virus [Cohen 2002]. Nevertheless, all persons who interact with macaques—in research settings, at zoological parks, in veterinary clinics, or as tourists at interactive venues—are at risk for B virus. Guidelines for exposure assessment and prophylaxis have been developed by the B Virus Working Group [Cohen 2002].

B. Medical Management of Animal Bites

The key priorities in management of bite victims are to address immediate or potential life-threatening sequelae, preserve normal tissue/organ function, prevent and treat localized or systemic infection, and maximize long-term cosmetic appearance. Most bite wounds are superficial, not life-threatening, and do not require hospitalization or intensive care. Nevertheless, a thorough examination is essential for even superficial and overtly minor wounds, especially those involving the hands or face, as they may overlie fractures, involve lacerated tendons, vessels, or nerves, penetrate into body cavities or joint spaces, or damage vital structures such as the eye [Fleisher 1999]. Because of the high risk of infection and functional loss for delicate bones and tendons, it is recommended that bite wounds to the hand be referred to a hand surgeon [Brook 1989]. Similarly, a cosmetic surgeon should be consulted early in the management of severe bite wounds to the face.

Bite wound first aid is an indispensable component of management and arguably more beneficial toward preventing infection than prophylactic antibiotic therapy. Vigorous washing with soap and water within the first few hours following the bite can substantially reduce the risk of infection. Liberal irrigation with normal saline or lactated Ringers solution further decreases the concentration of bacteria, particularly in deep, extensive, or puncture wounds. Most bite wounds are minor and can be managed by the victim at home. However, victims who incur bites that are severe, entail considerable tissue damage, are to parts of the body more sensitive or susceptible to infection, should seek immediate medical care.

Key steps in medical management of bite wounds
Wash with soap and water
Liberal irrigation
Debridement of devitalized tissue
If signs of infection are present
    Swab for culture
    Antibiotic therapy

Bite wounds that are severe, deep, or are more vulnerable to infection (e.g., were not immediately cleansed) should be monitored for signs of infection. Because most bite wound infections are due to the direct introduction of oral or skin flora into the wound at the time of the bite, evidence of infection is typically apparent within 24-72 hours. Common initial signs of infection include localized pain, swelling, and discoloration, cellulitis, a purulent or clear discharge, and regional lymphadenitis [Brook 1989, 2009; Smith 2000].

Swabs should be obtained from obviously infected wounds prior to cleaning and submitted for Gram's stain, culture (both aerobic and anaerobic), and antimicrobial sensitivity. Culture and sensitivity should be reserved for wounds that show clinical signs of infection and need for antimicrobial treatment

[Goldstein 1989]. In one case series, bacteria were cultured from 80 percent of bite wounds in patients who lacked other evidence of infection (viz., fever, neutrophilic inflammation, or purulent discharge) [Myers 2008].

Antimicrobial treatment of clinically infected bite wounds ideally should be based on culture and sensitivity results. In the absence of this information, empirical therapy should be directed against those micro-organisms most likely to be present; for dogs and cats the pathogens of principal concern include *Pasteurella*, *Streptococcus*, *Staphylococcus*, and anaerobes.

The cost-effectiveness of routine antimicrobial prophylaxis for bite wounds has yet to be demonstrated by well-designed randomized clinical trials. Nevertheless, antimicrobial prophylaxis could be considered for higher risk injuries, including a) moderate to severe wounds less than 8 hours old if edema or crushing of tissue is present; b) puncture wounds with possible bone or joint penetration; c) hand wounds; d) wounds adjacent to a prosthetic joint or in the genital area, and e) wounds in immunocompromised patients [Goldstein 2005]. Bite wounds that present more than 72 hours after the incident with no signs of infection do not merit prophylactic antimicrobial treatment. Prophylactic antimicrobials should be selected based on the micro-organisms most likely present in the biting animal's mouth and on the bite victim's skin. Standard recommendation for prophylactic treatment of animal bites is a broad-spectrum antimicrobial that covers both aerobic and anaerobic organisms, administered orally for 3-5 days.

IV. Animal Bite Prevention

Most animal bites are potentially preventable. Animal bite prevention involves all parties associated with a potential bite incident—bite victim, animal owner, and the community at large. Each has a role to play to reduce the occurrences of animal bites.

A. Potential victim

It is estimated that 30 to 90 percent of dog bites are in some manner provoked [Smith 2000]. Children especially should be taught how to interact safely with dogs known to them and avoid contact with dogs unknown to them (see box below) (http://www.cdph.ca.gov/programs/vphs/Documents/Dog%20Bite%20Book%20FINAL.pdf). Children too young to appreciate and learn these techniques should be supervised at all times when a dog is present. Young children should never be left alone with a dog, even one known to them.

Strategies for averting bites from a dog

Always ask permission from the owner before approaching or petting a dog.
Let the dog approach and sniff you first before touching it.
Gently pet the dog on the back or side, not on the head or face.
Remain calm and quiet. Do not make any sudden movements or loud noises.
Do not disturb a dog that is sleeping or eating.
Do not attempt to remove food, ball, toy, or other items from a dog's possession.
Do not put your face close to the dog's face or stare directly into its eyes.
If you are chased by a dog, stop, stand still and tall and quiet.

B. Animal owner

Animal owners have legal responsibility for their animals' actions, whether on or off their property. In 2011, 527 homeowners insurance claims for dog bites filed in California resulted in $20.3 million in costs, or approximately $38,500 per claim [Manning 2012].

1. *Selecting the appropriate pet*

Prospective pet owners should select a pet whose disposition is compatible with the environment, family structure, and dynamics of the household. Prospective dog owners should take time to properly socialize and train any new dog brought into their home.

2. *Socialization and training*

Proper socialization can enable dogs to recognize acceptable play that does not involve biting. Dogs should be socialized beginning at an early age (6-12 weeks) with other dogs and humans. Exposing the puppy to a broad variety of environments and situations will help to defuse fear and potentially aggressive response when confronting an unfamiliar setting. Puppies should be trained in fundamental leash obedience, as well as response to a set of simple voice commands. Group training classes for puppies provide both expert instruction and opportunities for socialization. The socialization and training skills learned at these classes should be reinforced throughout the dog's life.

3. *Desensitization to threatening situations*

A dog bites when it feels threatened or overwhelmed in a situation. When a dog becomes aggressive, it cannot learn at that moment. Punishing a dog in that instance will serve only to exacerbate its insecurity and fear. For most dogs, removing them from the situation will calm them. Some dogs may be calmed by providing reassurance during these situations and providing positive reinforcement (verbal praise, food treat) when the dog remains calm. For dogs with frequent recurrent aggression, it is critical to identify the root cause and attempt to desensitize it. A board-certified veterinary behaviorist can help to define a dog's aggressive behavior and can work with the dog owner to address this problem.

4. *Maintaining good health*

Dogs that are in pain may respond to normally benign stimuli in a disproportionate and aggressive manner. Also, certain diseases, medical conditions, and pharmaceuticals can alter a dog's hormonal

balance and directly lead to enhanced agitation and aggression. A dog with existing aggression problems should be thoroughly examined by a veterinarian to ensure that it has no contributory underlying medical condition. All dogs should be provided routine veterinary care to maintain maximal physical and psychological health. Gonadal alteration (ovariohysterectomy, castration) can modulate a dog's innate aggressive tendencies and remove a principal motivation for it to stray off property.

5. *SUPERVISION AND CONTROL*
Dogs should be confined to the owner's property in a secure fashion that not only restricts the dog from escaping the property but precludes unauthorized persons from entering spaces where direct contact with the dog is possible. Tying or chaining a dog to a fixed structure is neither a humane nor reliable means of restricting a dog's movement. All dogs should be under the direct physical control (e.g., leash with collar or harness) of a responsible adult when they are off their property and have potential contact with other dogs or people. Within the home, dogs should not be left alone with small children. Similarly, dogs that are reluctant to interact with a given individual or group of persons should not be compelled to do so. Dogs should always be permitted the option to avoid a situation that they perceive as threatening.

In contrast to dogs, most cat bites occur off the cat's owner's property. Ordinances to restrict or restrain movement of cats off their residential premises are rare. Many cat owners permit their cat considerable liberty to engage in itinerant wanderings unchecked and unsupervised. Free-roaming cats, be they owned or not, increase the range and number of persons susceptible to suffering a bite. The American Veterinary Medical Association, American Association of Feline Practitioners, American Animal Hospital Association, and other professional organizations strongly encourage owners to keep all cats indoors as much as possible. If allowed outdoors, these organizations recommend that cats be kept within a confined area, on a leash, or closely supervised to prevent contact with strangers and wild animals.

C. Community

1. *LEGISLATION AND ORDINANCES*

a. *Confinement and restraint ordinances*
Although most dog bites occur on the property where the dog lives, enactment and enforcement of local ordinances that constrain the number of free-roaming dogs reduces the risk to the wider community. Mandatory licensure of dogs compels the dog owner to assume legal responsibility for the actions of his/her animals. If a dog is identified as having bitten a person who is in a public place or lawfully on the owner's property, the owner is liable for any damages and is obligated to take measures to prevent additional bite episodes (California Civil Code §3342, 3342.5).

b. *"Dangerous dogs" and breed-specific legislation*
Some municipalities have instituted "dangerous" dog ordinances that focus on individual dogs that have exhibited harmful behavior (e.g., unprovoked attacks on persons or animals) and place primary responsibility for a dog's behavior on the owner. Model dangerous dog laws have been published [AVMA 2001].

Some other municipalities have entertained ordinances to prohibit or significantly restrict the private ownership of dogs belonging to breeds believed to be prone to aggression and responsible for many bite injuries. As mentioned earlier, of the dog bites reported to CDPH in 2011, pit bull terrier, German Shepherd or Shepherd mix, and Chihuahua were the breeds most frequently reported as contributing to bite incidents. However, determining a dog's breed solely by its physical appearance is not straightforward. Using physical markers, dogs are frequently assigned to breeds other than those represented in their genetic makeup [Voith 2009]. Additionally, behavior tendencies such as aggression are not strictly genetic and can vary widely among individuals within a given breed [Simpson 2012].

c. *Mandatory rabies vaccination*
Rabies vaccination does not directly influence the incidence of bites, but reduces the consequential risks and attendant responses should a bite occur. Disposition of both the biting animal (by animal control) and

the bite victim (by health care providers) is simplified if the biting animal has a well-documented history of rabies vaccination. Direct (expenditure of animal control resources) and indirect (provision of medical care, including rabies PEP, to uninsured victims) costs are reduced. Furthermore, mandating rabies vaccination ensures at minimum that the dog is seen by a veterinarian periodically, which may lead to better custodial responsibility on the part of the owner for the dog's health care and welfare.

2. *EDUCATION*

a. *Public officials*
Public officials and community leaders should be aware of animal bite morbidity in their jurisdiction and take appropriate steps toward bite prevention.

b. *Veterinarians and veterinary technicians*
Veterinarians are uniquely positioned to educate pet owners about preventing animal bites. Veterinarians can counsel prospective owners to select the species and breed of pet most appropriate to their desires and resources. They can also encourage proper socialization and obedience training, while ensuring that the animal's physical health is maintained. General practice veterinarians should identify a veterinarian who is board-certified by the American College of Veterinary Behaviorists with whom they can consult and/or to whom they can refer clients who have animals with aggression problems.

c. *Physicians and nurses*
Health care providers have traditionally confined their involvement with animal bites to providing immediate medical attention to the bite victim. Providers can take advantage of this opportunity to educate the patient and family on bite-avoidance strategies to prevent future incidents. Pediatricians can address the issue of animals in the home and offer strategies for reducing risk of bites. Physicians should consider establishing an informal dialogue with local veterinarians to facilitate mutually beneficial professional consultation on issues such as animal bites. Finally, providers should report cases of animal bites to the appropriate local agency.

d. *Workers in elevated risk occupations*
Any person whose job duties place him/her in direct or indirect contact with potentially biting animals should be apprised of the associated risks and provided training and skills to mitigate those risks. Persons working in veterinary clinics, animal control agencies, wildlife rehabilitation organizations, livestock operations, and certain laboratories can experience daily opportunities for animal bites. Other occupations such as postal service, utility workers, law enforcement, game wardens, and others may be occasionally incidentally placed in situations where there is potential contact with an animal. Training in the ability to recognize potentially threatening situations and techniques to avoid injury should be a standard part of the employer's Injury and Illness Prevention Plan. Only staff that have completed such training should be permitted to engage in potentially risky activities. All at-risk employees should receive periodic continuing education on risk identification and management on an appropriate recurring schedule.

e. *General public*
Children are most vulnerable to animal bites and benefit the most from animal bite prevention training. School districts should consider incorporating animal bite prevention information into the curriculum for students as early as kindergarten. Even a single session on the key strategies to prevent dog bites can improve behavior in young children [Chapman 2000]. School administrations can schedule special presentations by local animal control officers or veterinarians to further reinforce these skills. Parents should acquire these same skills and re-emphasize their importance to their children in the home and elsewhere. Similarly, elderly persons should be provided information of risks to themselves from animals, as well as possible risks their own animals pose to young children (e.g., grandchildren) and other persons to whom they are not accustomed. Persons who engage in outdoor recreational activities (e.g., running, bicycling, hiking) should be instructed in strategies to defuse a situation in which they encounter a potentially biting animal. Finally, local print and broadcast media can disseminate objective and factual information on the risks and preventive measures for animal bites.

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Animal Bite Incident and Rabies Exposure Report

REPORTING JURISDICTION			
Jurisdiction	*Person Completing Form*	*Telephone Number*	*Email Address*

INITIAL BITE REPORT			
Date when Bite Reported	*Name of Person Reporting Bite*	*Telephone Number*	*Relationship to Bite Victim*

BITE INCIDENT			
Date and Time where Bite Occurred			*Name and Contact Information of Other Witnesses*
Name of Place/Location where Bite Occurred (if applicable, such as name of park, etc.)			
Address: Number, Street		*Apt./Unit No.*	
City	*State*	*ZIP Code*	

Describe Circumstances of Bite Incident

BITE VICTIM			
Name			*Telephone Number*
Address: Number, Street		*Apt./Unit No.*	*Mobile Number*
City	*State*	*ZIP Code*	*Email Address*
Sex ☐ Male ☐ Female ☐ Unknown	*Age*	*Adult Guardian Name and Telephone Number (if victim < 18 years)*	

Location of Bite Wound on Body	
Did the bite break the skin? ☐ Yes ☐ No ☐ Unknown	*Was the wound promptly cleaned with soap and water?* ☐ Yes ☐ No ☐ Unknown
Did the victim seek medical care? ☐ Yes ☐ No ☐ Unknown	*Date and Time of Medical Care*
Name of Medical Provider	*Medical Provider Telephone Number*
Was the victim previously vaccinated against rabies? ☐ Yes ☐ No ☐ Unknown	*Date(s) of Previous Rabies Vaccination*
Was rabies post-exposure prophylaxis (PEP) initiated? ☐ Yes ☐ No ☐ Unknown	*Name of Products Used*

PEP DATES				
HRIG	*Day 0*	*Day 3*	*Day 7*	*Day 14*

BITING ANIMAL

Animal Name	*License or Identification Number*	*Age (years or months)*
Species	*Breed/Physical Description*	
Color	*Sex* ☐ Male ☐ Female ☐ Unknown	*Reproductive Status* ☐ Intact ☐ Neutered/spayed ☐ Unknown
Address where Animal Kept or Recovered: Number, Street		
City	*State*	*ZIP Code*

Ownership Status
☐ Pet ☐ Stray ☐ Feral ☐ Livestock ☐ Wild, unowned ☐ Wild, captive ☐ Unknown

Owner/Responsible Party Name			*Telephone Number*
Address: Number, Street		*Apt./Unit No.*	*Mobile Number*
City	*State*	*ZIP Code*	*Email Address*

Where is the animal kept?
☐ Outdoors only ☐ Indoors only ☐ Outdoors and indoors ☐ Unknown

Was the animal vaccinated against rabies? ☐ Yes ☐ No ☐ Unknown	*Most Recent Vaccination Date*	*Tag Number*
Vaccine Name	*Vaccinating Veterinarian Name*	*Vaccinating Veterinarian Telephone Number*

Was the animal been ill within the last 10 days or acting abnormally at the time of the bite? ☐ Yes ☐ No ☐ Unknown	*If Yes, Describe Illness/Abnormal Behavior*
Was the animal seen by a veterinarian for this illness? ☐ Yes ☐ No ☐ Unknown	*Date Seen*
Veterinarian Name	*Veterinarian Telephone Number*

ACTIONS TAKEN/DISPOSITION OF BITING ANIMAL

Actions Taken/Disposition of Biting Animal
☐ Euthanized ☐ Placed under quarantine for observation ☐ Other (specify): _____
☐ Died ☐ Unable to locate

If the animal was euthanized or died:	*Date of Death*	*Was the brain tested for rabies?* ☐ Yes ☐ No ☐ Unknown	*Submission Date*
	Laboratory Name		*Results*
If the animal was placed under quarantine:	*Date Placed*		*Date Released*
	Duration	*Quarantine Location* ☐ Home ☐ Animal shelter ☐ Other (specify): _____	
Was bite victim notified of quarantine or testing outcome? ☐ Yes ☐ No ☐ Unknown		*Date Victim Notified*	

ADDITIONAL NOTES

Signature: _____ Date: _____

APPENDIX B
MODEL ANIMAL BITE RABIES QUARANTINE ORDER

ANIMAL BITE RABIES QUARANTINE NOTICE

<Date>

Animal species: _____

Description: _____
(age) (sex) (breed) (color/markings)

Location: _____

In compliance with state and <county/city> law (California Health & Safety Code §121170; California Code of Regulations, Title 17, §2606; <applicable local/county ordinance>), the animal identified above and owned/harbored by you at the indicated address is hereby ordered confined to said premises under the conditions defined below for purposes of quarantine for possible rabies exposure.

☐ The animal has bitten or otherwise potentially exposed a person or other animal to rabies virus and is quarantined for a minimum of **10 days**.

☐ The animal has been bitten by or otherwise been exposed to a potentially rabid animal and quarantined for a minimum period of

☐ **30 days** ☐ **180 days**

Quarantine conditions

- The animal must be confined at all times in an enclosed space that prevents contact with people, other pets, and wild animals.
- At no time may the animal be removed from the enclosure without prior written permission of <local rabies control authority>.
- At any time the animal becomes ill, shows signs of abnormal behavior, or dies, <local rabies control authority> must be notified immediately.
- The local health officer may authorize at any time that the animal be euthanized for purposes of laboratory examination for rabies.
- The animal may be released from quarantine only upon completion of the prescribed quarantine period and by authorization of <local rabies control authority>.

I understand and agree to abide by the conditions under which the above named animal, for which I am the responsible owner or custodian, is to be quarantined. I understand that violation of the conditions of this quarantine order, whether by volition or negligence, is punishable as a misdemeanor under California Health & Safety Code (§121170).

_____ _____
Animal owner (print) Animal owner (signature) Date

_____ _____
Issuing official (print) Issuing official (signature) Date

<Local rabies control authority: Business hours Tel: ###-####, After hours Tel: ###-#### >