Impact of Dog Transport on High-Risk Infectious Diseases

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KEYWORDS

• Importation • Translocation • Transportation • Companion animals
• Infectious disease risk

KEY POINTS

- Translocation of dogs inherently poses infectious disease risks when pathogen distributions vary between regions, even within the same country.
- Concerns include introduction of novel pathogens that can infect dogs, zoonotic pathogens, pathogens that can become established in existing reservoirs or vectors, and vectors that might carry pathogens and/or become established in a new region.
- Implementation of mandatory screening or testing programs before interregional movement or importation of dogs is not feasible in many cases because of a plethora of economic, practical, and political reasons.
- Education of all stakeholders involved to raise awareness of the potential disease consequences of translocation events via the movement of dogs needs to be a priority.

INTRODUCTION

Geographic boundaries and barriers that previously helped to keep infectious diseases regionally contained can now be bridged in a matter of hours, by plane, train, or automobile. Even many political boundaries pose minimal challenge to temporary visitors, and with them come their infectious pathogens, both foreign and familiar. Given the strength of the human-animal bond and frequent inclusion of dogs in the

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family unit, it is not surprising that where people go, dogs seem to eventually follow, and they bring all of their microbes along as well. Although both temporary and permanent translocation of dogs is clearly a common occurrence, it is extremely difficult to accurately quantify, largely because of a lack of importation regulations by which the data may be collected, and lack of sharing of these data by the agencies responsible. For example, in Canada, the Canadian Border Services Agency ostensibly collects data regarding dog entry and applies separate codes to dogs that are imported either personally or commercially. However, the number of animals imported under each category and any additional data on the origin or destination of these animals are not available.[1] Based on an independent estimate, at least 6189 dogs from 29 different countries were imported into Canada in 2013 to 2014 through 218 rescue organizations alone.[1] This number is likely a gross underestimation of the actual number of imported dogs, because there is no registration or licensing requirement for rescue organizations to ensure they were all identified, and these numbers do not include animals that were personally imported by individuals for a variety of reasons, such as vacation, seasonal residence, breeding, or competition, in addition to adoption. It was estimated that more than 287,000 dogs were imported into the United States in 2006 through land border crossings and airports.[2] There is even less information available on illegal movement of dogs that may occur, particularly by ground transportation over poorly protected borders such as that between the United States and Canada or those of some European countries.

Translocation of dogs, regulated or unregulated, legal or covert, small or large scale, inherently poses infectious disease risks when pathogen distributions vary between regions, even within the same country. There are many drivers of this kind of canine traffic, and the transportation process itself can exacerbate the risks. Concerns include introduction of novel pathogens that can infect dogs (eg, canine influenza virus), introduction of pathogens that can infect people (eg, rabies virus), introduction of pathogens that can become established in existing reservoirs or vectors (eg, tick-borne or mosquito-borne pathogens), and introduction of vectors that might carry pathogens and/or become established in a new region (eg, ticks).

DRIVERS OF CANINE MOVEMENT

The drivers of long-distance dog transport are many and varied, and the risks of pathogen movement vary by the reason for translocation. **Table 1** provides reasons/means and examples of canine importation into a country with minimal importation requirements, such as Canada.

Because of the scarcity of data available regarding canine importation, it is not possible to accurately quantify each of these drivers, but dogs transported by rescue organization and puppies imported for retail sale (which are not mutually exclusive groups) represent the largest number of high-risk animals.[2,4] The reasons for rescuing dogs are equally many and varied, including displacement of dogs by natural disasters (eg, hurricanes),[5–7] high-profile international events (eg, Olympic games),[8,9] the canine meat industry in Asia,[10] and puppy mills.[11] In addition, it has been reported that at least 1 commercial puppy mill in the United States has set up its own so-called rescue organization in order to circumvent regulations and bylaws designed to deter sales of dogs from such facilities, by essentially laundering the puppies through the rescue before sale to retailers.[12] The medical requirements stipulated by rescues, shelters, and other organizations that may receive rescue dogs, including quarantine periods, are highly variable and in many cases are nonexistent.[13]

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Table 1
Reasons for, and means of, canine importation into Canada

Reason/Means	Examples	Risk Mitigating Factors	Risk Enhancing Factors
Personal pet reentering country with owner after short-term trip	Dog returning with resident vacationing seasonally in another country; show or breeding animal that was exported for a short term	Dog ownership is clear, strong owner attachment, dog likely receives some veterinary care in order to fulfill minimum requirements to cross the border (eg, rabies vaccination certificate)	Owners may not be aware of disease risks in other regions, and may not consult a local veterinarian. May increase likelihood of regionally dependent carriage/infection on entry
Personal pet entering country with owner for first time or reentering after long-term trip	Family moving to country for work bringing the family dog; refugees with pet dog	Dog ownership is clear, strong owner attachment, more likely to provide care if dog is/becomes ill	Long duration or wider variety of potential exposures to diseases in country/region of origin. May increase likelihood of regionally dependent pathogen carriage/infection on entry
Recently adopted pet entering country with owner who is either entering or reentering	Vacationer returning with an adopted street dog; military personnel returning from overseas deployment with an adopted dog	Dog ownership is clear, well-intentioned owner more likely to provide care if dog is/becomes ill	Animal history is typically unknown, dog may have only received cursory veterinary care before importation (eg, to obtain rabies vaccination certificate), dog may be too young for some vaccinations (eg, rabies), vaccination in some countries may be less reliable (eg, poor vaccine quality, cold chain not maintained, falsified certificates)
Animal being imported for a specific commercial purpose (eg, research, breeding, competition, prearranged individual sale)	Purpose-bred specific pathogen–free dogs being imported by a research facility; individual purebred puppy imported for sale to a specific individual (ie, not a retailer)	Dog ownership is clear, high sentimental and/or commercial value, more likely to provide care if dog is/becomes ill, typically increased requirements for entry compared with personal dogs	Importer may not be aware of disease risks in other regions, may be at increased risk of pathogen carriage/infection in competition and breeding dogs because of high exposure to other dogs, or antimicrobial use practices[3]

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Table 1
(*continued*)

Reason/Means	Examples	Risk Mitigating Factors	Risk Enhancing Factors
Rescue animal being imported under commercial dog rules (including animals from puppy mills)	Group of dogs arriving with an individual working for a rescue organization	Typically increased requirements for entry compared with personal dogs (eg, import permit, microchip or tattoo, veterinary health certificate, rabies vaccination certificate)	Dog's final owner is unknown, adoptability may be unknown, animal history is typically unknown. Other risks as above, plus typically originating from high-risk facility or area (eg, crowded, suboptimal care/ sanitation)
Rescue animal being imported under guise of personal pet (including animals from puppy mills)	Lead rescue individual travels to a foreign country and returns with several dogs at once, claiming them all as personal pets when in fact hoping to adopt them out once in the country	Few to none. High-risk rescue dog imported with the requirements for a low-risk personal dog. Sentimental or commercial value questionable/variable	Dog's final owner is unknown, adoptability may be unknown, animal history is typically unknown, minimal entry requirements (ie, rabies vaccination). Other risks as above
Rescue animal being imported on behalf of owner/adopter who has never seen the dog (including animals from puppy mills)	Dog adopted via an Internet campaign through a rescue organization, brought in by third party to be delivered to new owner in new country	Well-intentioned owner more likely to provide care if dog is/becomes ill, assuming adoption goes through	Unclear how to verify ownership, owner may ultimately decide not to adopt dog after importation. Other risks as above
Personal pet entering country for veterinary care	Dog requiring a highly specialized surgical procedure for which the nearest expertise and equipment is across the border at a referral hospital in an adjacent country (eg, Canada, United States)	Primarily occurs for referral/tertiary care of personal pets, not typically sought for rescue/unadopted animals, dog ownership is clear, being taken directly to a veterinary facility so likely to have limited contact with local dogs	Inherently animals are not healthy. Personnel at referral centers near the border or near major ports of entry need to be particularly aware of risks of imported diseases

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STRESS DURING TRANSPORT

The way in which dogs are transported can also have a significant impact on their susceptibility to disease, pathogen shedding, and overall likelihood of disease transmission before, during, and after transport. Individuals or organizations often import groups of dogs, from a few dogs to several dozen at a time. These animals may come from a single source or multiple sources in the country of origin but be brought together in the same holding area and loaded into the same cargo area of a plane or a truck. Health screening, vaccination, and other preventive medicine measures at this and other stages are highly variable and often unregulated. Even if they are individually caged, the mixing, crowding, potentially poor ventilation, and the inability to adequately control fecal and urinary contamination lead to ideal conditions for transmission of respiratory and gastrointestinal pathogens. On commercial carriers, there is potential for multiple shipments of dogs to be transported on the same vessel, along with individually owned personal animals, and in the event of a disease outbreak it can be extremely difficult to trace back these contacts to determine which animals may be at risk and to alert their owners. There may also be undocumented contact with various individuals throughout the transportation process, which can be dangerously problematic if the animals in question are subsequently diagnosed with a zoonotic disease (eg, rabies). The entire transportation process can also cause both physiologic and psychological stress, particularly on long trips during which dogs may receive marginally adequate to inadequate food, water, and exercise; thermal stress from fluctuating temperatures; and sudden exposure to entirely unfamiliar environments, such as airports, which are often loud and chaotic. In combination, these factors are likely to have an important effect on immune function,[14,15] which may lead to both increased shedding of pathogens already harbored by the dog (clinically and subclinically) and susceptibility to new pathogens. In some cases, these factors also constitute a significant welfare issue, particularly in the case of dogs that are already clinically ill or injured, because appropriate veterinary care typically cannot be provided en route. Furthermore, even after arrival at their final destination, these dogs continue to be stressed by further changes in environment and diet. In most countries there is no regulatory requirement or support for any form of postarrival quarantine, and only a minority of rescue organizations implement such quarantine on a voluntary basis.[13] New owners or caretakers therefore often introduce the animals to other resident dogs soon after arrival at their final destination, in an attempt to begin socializing the new dogs, which presents risks to both the new and resident dogs. Dispersal of groups of dogs to numerous locations further increases the risk of spread of pathogens transmitted within the group during transport.

EXAMPLES OF POTENTIAL IMPACT OF HIGH-RISK DISEASES

The following are examples of specific diseases that are considered high risk with regard to interregional movement and importation of dogs, particularly to North America and much of Europe. This list is not exhaustive, and the relative risk of each disease varies by region based on current disease prevalence, host, vector, and habitat availability. These diseases are used to show how different pathogen characteristics and transmission pathways affect the impact of movement of infected dogs.

Rabies

Because rabies is not transmitted via respiratory secretions or the fecal-oral route as many other common pathogens are, and because the disease is rapidly fatal within a short time from when a dog begins shedding the virus and subsequently develops

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clinical signs, movement of an infected dog is less likely to have a significant impact on the local epidemiology of rabies in developed or other rabies-endemic countries compared with other canine diseases. Instead, the most significant risk is the potential for human exposure either in transit or on arrival, depending on the time frame of infectivity. Trace-backs of contacts in such cases can often be extremely challenging, because dogs may move through multiple jurisdictions and large public transport hubs, such as airports.[16] From 2001 to 2013, 18 cases of rabies in dogs (and 1 in a kitten) imported from rabies-enzootic countries were reported in western Europe, of which only 2 animals were identified by customs officials and placed under quarantine.[17] For each case, an average of 34 (range, 0–187) persons and other animals required postexposure prophylaxis, and 1 case resulted in infection and the deaths of 2 resident dogs in France.[17]

Regulations requiring animals to be vaccinated for rabies before importation only serve to help protect the dog from infection if it is exposed after arrival. The incubation period for rabies in dogs can exceed 6 months, and a dog that is vaccinated before travel but after exposure may still harbor the virus and go on to develop clinical disease. Six of the 19 rabid animals imported into western Europe from 2001 to 2013 were reportedly vaccinated for rabies, but most of the vaccinated pets did not meet the recommendations for age of vaccination, revaccination interval, or serologic analysis before import.[17]

Importantly, rabies vaccines are only licensed for puppies older than a certain age (2–3 months), but infection can occur before this age and may affect multiple animals within a litter. Rabies infection in puppies is particularly problematic from a public health standpoint because of the potential for dispersal of the puppies to multiple owners and regions, high animal-human contact because of the way in which puppies are often closely and extensively handled by people, and the tendency for young untrained puppies to bite, causing minor wounds that may not be considered significant but can nonetheless potentially transmit rabies.

In 2011 to 2012, nearly 2800 dogs that were unvaccinated for rabies entered the United States and were placed under confinement agreements, which stipulated that contact with humans and other animals must be restricted until they were fully immunized.[4] Most of these were puppies imported for commercial sale or rescue purposes.[4] However, there is often poor compliance with such confinement agreements; more than 4000 confinement agreement violations were recorded in 2006 in the United States.[2] Falsified rabies vaccination certificates (and possibly other health documents required for importation) are also a growing concern.[18]

Canine Influenza

Canine influenza virus (CIV; H3N8 and H3N2) generally causes self-limiting mild to moderate clinical disease in dogs. However, like other influenza A viruses, it is highly transmissible, particularly within naive and high-density populations such as shelters, and can cause serious and even fatal infections in some animals. A single-point introduction of H3N2 CIV from a dog imported from South Korea is suspected to have initiated the 2015 outbreak in the Chicago, Illinois, area and, within a year, H3N2 CIV had spread to multiple eastern and southeastern US states, with smaller isolated outbreaks in other areas of the country.[19] Subsequent significant outbreaks have been identified in California, Nevada, and New York, as well as Ontario, Canada, through the movement of infected dogs from Asia or from other affected states.[20–22] Testing for CIV before movement of dogs is problematic in terms of timing requirements. Viral shedding precedes clinical signs and persists (possibly intermittently) for up to 24 days.[23] Commercially available vaccines can decrease the likelihood and severity

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of infection but are not 100% effective for preventing infection or active shedding, and products are strain specific. Based on its short incubation period, the most effective means of controlling the risk of CIV in translocated dogs would be quarantine for 48 to 96 hours along with polymerase chain reaction testing to detect shedding in subclinically infected dogs, but the potentially significant costs of implementing such precautions must be weighed against the currently limited risk to public and animal health. To date, there is no evidence of dog-to-human transmission of either circulating strain of CIV, but concern regarding the potential for a reassortment event should a dog (or a person) be concurrently infected with both CIV and a human seasonal influenza virus remains.[19]

Echinococcosis

Echinococcus multilocularis (EM) is a parasite of public health significance that can also be carried by domestic dogs. It is widely distributed in the northern hemisphere, including parts of central Europe, most of northern and central Eurasia, and parts of North America, specifically the northern tundra zone and the north central region.[24] In recent decades, the risk areas in Europe and North America seem to have expanded significantly.[24,25] Several European countries require treatment of dogs before importation in order to prevent the introduction of this particular tapeworm.[1] More recently, EM has been identified in southern Ontario, Canada,[26] and could potentially be present but as-yet undetected in adjacent northeastern US states. Its spread in this case was likely primarily through wildlife involved in the tapeworm's sylvatic life cycle (ie, wild canids, rodents), but it is possible that importation of dogs with patent intestinal infections from more endemic areas (eg, central Europe, China) may have also played a role. Strain typing of EM in emerging areas could potentially contribute significantly to the current understanding of the spread of this parasite in some areas.[25] Imported animals harboring intestinal infection with EM are capable of causing significant environmental contamination with parasite eggs, potentially resulting in serious infections in people in the form of alveolar echinococcosis (the intermediate stage of the parasite), and infection of rodents or other small mammals, leading to increased risk of spread to both wild canids and other domestic dogs. Although treatment and control of EM in dogs with intestinal infection is straightforward and effective, once the wildlife cycle is established it becomes essentially impossible to eradicate, resulting in ongoing risk to domestic dogs and a significant public health risk, particularly in densely populated regions.[24]

Leishmaniasis

Leishmania infantum is endemic to the Mediterranean basin, the Middle East, southern Asia, Iran, Armenia, Afghanistan, and central Asia; *Leishmania chagasi* is endemic in Central and South America, and *Leishmania mexicana* is endemic to parts of south-central Texas.[27] Although there is some potential for direct transmission of these protozoa between dogs and humans via direct contact with cutaneous lesions or other infected tissues, the parasite is normally transmitted by certain phlebotomine sandflies (*Lutzomyia* or *Phlebotomus* spp). In areas where no known competent vector is thought to exist, the risk of transmission to other animals and people should be limited, but there is always a risk that an infected dog may encounter an as-yet unknown competent vector. Subsequent spread to other susceptible hosts, including wildlife, can rapidly lead to establishment of a sylvatic cycle, after which eradication is essentially impossible. Furthermore, treatment of infected dogs, even with long-term antimicrobials, is generally ineffective at eliminating the infection; therefore, dogs are lifelong carriers and reservoirs of infection. Despite the lack of a known competent vector

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species in the eastern United States and Canada, in 1999 there was a large outbreak of visceral leishmaniasis in foxhounds in New York. A subsequent serosurvey showed that canine visceral leishmaniasis was enzootic in foxhounds specifically in 18 US states and 2 Canadian provinces (Ontario, Nova Scotia).[28] The range of *Lutzomyia shannoni* sandflies overlapped with many of the affected hunt clubs along the east coast,[28] and it was later discovered that *Lutzomyia vexator* were widespread in the New York area, but it is unknown whether they played a role in local transmission,[29] and no evidence of human infection was identified.[28] It is highly likely that the importation of infected dogs from other endemic regions was involved in the early stages of the outbreak,[27] and infection was then propagated through direct transmission between dogs within specific breed groups, via contact such as bites, breeding, needle reuse, and vertical transmission.[28]

Heartworm

When imported into nonendemic or low-endemic areas, dogs infected by heartworm (*Dirofilaria immitis*) pose a significant threat to local dogs. Unlike a pathogen such as *Leishmania* spp that requires a specific insect vector, or tick-borne pathogens of which dogs are end hosts and therefore cannot infect other tick vectors, competent mosquito vectors for *D immitis* are widespread and can easily acquire the parasite from a microfilaremic dog and transmit it to others. In 2005, thousands of dogs were dispersed from the Gulf coast to other areas of the United States and Canada following Hurricane Katrina, and one study showed 48.8% of these animals were heartworm antigen positive.[5] Many of the locations to which these dogs were transported throughout the United States and Canada had low prevalences of *D immitis* in the mosquito and dog populations. The ultimate effects of such movement on *D immitis* risk are unquantified. A similar exodus of dogs from high-risk southern US states occurred in 2017 following Hurricane Harvey and Hurricane Irma.[6,7] Wild canids such as coyotes can also be infected and thus establish a wildlife reservoir that is nearly impossible to eradicate; in endemic areas of North America, coyotes are considered likely to be the most important heartworm reservoirs.[30] Testing for heartworm is simple and noninvasive, but the long incubation period of the parasite poses an additional challenge, necessitating testing of dogs before transport and also at 6 to 12 months following relocation, depending on documentation of preventive treatment, in order to ensure they are free from infection.[31]

Screwworm

New-world and old-world screwworm (*Cochliomyia hominivorax* and *Chrysomyia bezziana*, respectively) can have significant trade implications for some countries, primarily because of their potential to affect livestock. The larvae can infect any warm-blooded or cold-blooded animal, but mammals are most commonly affected. Although the flies cannot complete their life cycle when the soil temperature is consistently less than 8°C,[32] climate change may increase their potential range. Eradication of screwworm from the southern United States, Mexico, and most of Central America required the development and release of sterile male flies, in addition to control of animal movements.[32] During a subsequent incursion in 2016 in the Florida Keys, which included 3 confirmed canine infections, checkpoints were established at which all people and animals (including dogs) had to be verified as free of suspicious lesions, in order to prevent further spread of the parasite to the mainland.[33] That particular outbreak severely threatened the survival of the endangered key deer, many of which became infected.[33] Although the source of the incursion was never definitively determined, the outbreak shows the potential effects of any infected animal, including a

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dog, traveling to an area with a suitable climate to complete the insect's life cycle. Fortunately, lesions associated with infection are typically readily visible, and diagnosis and treatment are usually straightforward once the larvae are found.

Ticks and Tick-Borne Diseases

The role of translocated dogs in the spread of ticks and tick-borne diseases is fairly small compared with the effect of climate change on the expansion of suitable tick habitats[34,35] and the natural migration of ticks into these areas via wildlife hosts such as migratory birds, which may disperse hundreds of millions of ticks across vast geographic areas annually.[36] However, recognition of tick-borne diseases in dogs that have been transported from high-endemic to low-endemic regions is a concern,[37] particularly because early clinical signs of infection can be nonspecific, and local veterinary practitioners may not be aware of the need to consider such pathogens in their differential diagnoses. Even when they are considered, testing can be problematic because most readily available serologic tests cannot differentiate active infection from previous exposure. There is also risk of zoonotic transmission of pathogens to owners or veterinary personnel who attempt to remove infected ticks from dogs, should the tick be accidently crushed in the process.[38]

Adventitial ticks on imported dogs are generally of limited concern in terms of their ability to establish new tick populations or to spread infection by subsequently attaching to a new host, but there are exceptions. *Rhipicephalus sanguineus* (brown dog tick) is already one of the most widely distributed ticks in the world but is also a vector of *Ehrlichia canis*, *Babesia canis*, *Anaplasma platys*, and several rickettsial species, including *Rickettsia rickettsii*.[37] Unlike most other ticks, it is capable of completing its entire life cycle indoors (and on 1 host), thus infected ticks on an imported dog can pose a risk to other dogs living on or visiting the premises (eg, kennel, shelter, veterinary clinic). *Haemaphysalis longicornis* (longhorned tick) was recently found in the northeastern United States.[39] Although primarily considered a livestock pest in east Asia, Australia, and New Zealand, the tick feeds on a variety of hosts, including humans and dogs.[37,39] Its ability to transmit pathogens of concern in North America remains unclear, but specimens infected with *Borrelia* spp, *Ehrlichia* spp, *Anaplasma* spp, and *Rickettsia* spp have been found in Asia.[39] This tick has also been implicated in the transmission of a bunyavirus, associated with severe fever with thrombocytopenia syndrome.[39] One of the risks associated with *H longicornis* is related to its unusual ability to reproduce by parthenogenesis; that is, females can reproduce without mating.[39] This ability facilitates the establishment of an invasive population even if only a small number of ticks, or even a single tick, is translocated on a dog or other animal or person. Prompt removal of ticks on such individuals, either immediately after or ideally before transport, therefore remains prudent.

Reproductive Diseases

Purebred animals with highly desirable genetics may be transported long distances, even transcontinentally, for breeding. There can also be substantial movement of breeding stock between large, high-volume breeding kennels,[40] which may be associated with far less medical scrutiny based on lower value of individual animals. Imported rescue dogs are also often sexually intact, particularly when they come from regions where the availability of veterinary services is limited, and then they may or may not be spayed or neutered on arrival at their final destinations. Breeding animals are at a higher risk for spreading specific reproductive diseases. Infected breeding sires in particular have the potential to be point sources of disease by breeding with multiple bitches. Canine brucellosis, caused by *Brucella canis*, can be transmitted

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during mating and is also a zoonotic concern. This bacterium is thought to be an under-recognized pathogen in dogs and humans worldwide, but few countries have *B canis*–specific regulations.[41] Outbreaks in breeding kennels in several countries have been linked to interregional movement and importation of dogs from these types of facilities and are a significant source of economic loss in breeding facilities in the United States.[40,41] Canine transmissible venereal tumor (CTVT) is spread by transfer of living cancer cells during copulation. It is endemic in at least 90 countries worldwide, and is associated with free-roaming intact dogs.[42] Although its prevalence has significantly decreased in northern Europe, in the United States and Australia, the disease remains endemic in remote indigenous communities.[42] Some of these populations of free-roaming dogs may be targeted by individuals or organizations hoping to relocate the animals, increasing the risk of spread of CTVT to other areas. Although CTVT is also a risk with the movement of intact dogs, unlike *B canis*, it can be easily and effectively diagnosed and treated in most cases if these measures are performed promptly.[43]

Vaccine-Preventable Diseases

Exposure to vaccine-preventable diseases from translocated dogs is a common risk that tends to attract far less attention than exposure to higher-profile exotic or zoonotic diseases. These diseases include, but are not limited to, canine distemper virus (CDV), canine parvovirus (CPV), and pathogens comprising the canine infectious respiratory disease complex. Rescued dogs that may have previously received little to no veterinary care, perhaps coming from or transported under high-density conditions, are at particularly high risk. Although few published reports are available, CDV is likely the single largest cause of import-associated illness and mortality in dogs, through both acute disease that develops after arrival and, perhaps more importantly, severe neurologic disease that may only develop later in dogs that were clinically normal on arrival. Transmission of CDV from imported dogs to housemates has (anecdotally) also occurred on numerous occasions. One study of a shipment of 15 rescue dogs imported from Hungary to Switzerland reported that 85% of the dogs had active CDV infection, despite all dogs having been vaccinated 7 to 30 days before import.[44] Shedding persisted for up to 4 months in at least 2 dogs, but none of the resident in-contact dogs (all of which had been vaccinated for CDV at least once in the past) developed clinical signs of infection.[44] The estimated vaccination rate for CDV in dogs in Switzerland is 60% to 70%, which is inadequate to provide population immunity, and leaves a substantial number of individual dogs unprotected in case of exposure.[44] Companion animal vaccination rates in other regions are largely unknown but are likely to be similar or lower.

SUMMARY

Many of the drivers of canine movement stem from a strong human-animal bond and a desire to alleviate animal suffering. However, the individuals and organizations involved often do not realize the variable risk of disease transmission associated with many of these scenarios, and thus the potential greater long-term impact of their actions beyond the individual dogs. For many of the diseases discussed here, the implementation of mandatory screening or testing programs before interregional movement or importation of dogs is not feasible because of a plethora of economic, practical, and political reasons.[1] Education of stakeholders, including the public, rescue organizations, shelters, transportation companies, and veterinarians, to raise awareness of these diseases, and the potential consequences of translocation events

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via the movement of dogs, needs to be a priority. Those motivated by a genuine desire to do the right thing are likely to be the most receptive to information and guidance about how to mitigate disease risks associated with the long-distance movement of dogs. Those involved in the industry purely for profit are more likely to only respond to requirements imposed on them by others, including recipients, transporters, and various levels of government. As the world becomes "smaller" and long-distance travel becomes faster and easier for both people and animals alike, it is critical that all stakeholders involved in the movement of dogs do their part to help mitigate these disease risks.

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