Public Veterinary Medicine: Public Health

Compendium of Measures to Prevent Disease Associated with Animals in Public Settings, 2017

The National Association of State Public Health Veterinarians Animal Contact Compendium Committee

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This document has not undergone peer review; opinions expressed are not necessarily those of the AVMA.

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Preface

The Compendium of Measures to Prevent Disease Associated with Animals in Public Settings has been published by the NASPHV and the CDC since 2005.[1–3] This compendium provides standardized recommendations for public health officials, veterinarians, animal venue operators, animal exhibitors, visitors to animal venues and exhibits, teachers, camp operators, and others concerned with control of disease and with minimizing health risks associated with animal contact in public settings. The report has undergone several revisions, and this document updates information provided in the 2013 compendium.[3]

I. Introduction

Contact with animals in public settings (eg, fairs, educational farms, petting zoos, and schools) provides opportunities for entertainment and education. The NASPHV understands the positive benefits of human-animal contact. However, an inadequate understanding among animal exhibitors and visitors in regard to disease transmission and animal behavior can increase the likelihood of infectious disease exposures, injuries, and other health problems among visitors in these settings. Zoonotic diseases (ie, zoonoses) are diseases shared between animals and humans; many of these diseases are potentially transmitted from animals to people in public animal contact venues **(Appendix 1)**. Of particular concern are instances in which zoonotic disease outbreaks result in numerous people becoming ill. During 1991 through 2005, the number of enteric disease outbreaks associated with animals in public settings increased.[4] During 2010 through 2015, approximately 100 human infectious disease outbreaks involving animals in public settings were reported to the CDC (unpublished data, 2017). Such outbreaks have substantial medical, public health, legal, and economic effects.

Although completely eliminating risks from animal contact is not possible, this report provides recommendations for minimizing associated disease and injury. The NASPHV recommends that local and state public health, agricultural, animal health, wildlife, and environmental agencies use these recommendations to establish their own guidelines or regulations for reducing the risk for disease from human-animal contact in public settings. Public contact with ani-

ABBREVIATIONS

NASPHV	National Association of State Public Health Veterinarians
STEC	Shiga toxin–producing *Escherichia coli*

mals is permitted in numerous types of venues (eg, animal displays, petting zoos, animal swap meets, pet stores, feed stores, zoological institutions, nature parks, circuses, carnivals, educational farms, livestock birthing exhibits, agricultural fairs, childcare facilities or schools, camps, agritourism venues, live animal markets, and wildlife photo opportunity settings). Managers of these venues should use the information in this report in consultation with veterinarians, public health officials, state and local agriculture officials, or other professionals to reduce risks for disease transmission.

Guidelines to reduce risks for disease from animals in health-care facilities, veterinary facilities, and various other occupational settings as well as from service animals (eg, guide dogs) have been developed.[5–12] Although not specifically addressed here, the general principles and recommendations in this report are applicable to these settings.

II. Methods

The NASPHV periodically updates the recommendations to prevent disease associated with animals in public settings. To revise the 2013 compendium,[3] the NASPHV Animal Contact Compendium Committee members and external consultants met in Atlanta from October 4 through 6, 2016. The revision process included reviewing literature pertaining to outbreaks and diseases associated with animals in public settings since the previous compendium was published; examining reports of animal contact–associated enteric and nonenteric disease outbreaks from the CDC National Outbreak Reporting System as well as from CDC subject matter experts and state public health veterinarians; reviewing specific input solicited from NASPHV members and committee consultants; and evaluating publications and presentations from experts on specific topics of relevance to the compendium revision process. A committee consensus was required to add or modify existing language or recommendations. The 2017 recommendations reported here have been updated with new information and data on zoonotic disease outbreaks and prevention measures.

III. Background

A. Infectious diseases associated with animals in public settings

1. Diseases transmitted by direct or indirect animal contact

One of the most common routes of disease transmission from animals to people is direct physical contact with the animal, which includes touching, holding, kissing, being bitten, and being scratched. Disease transmission also occurs through indirect contact with an animal through contact with a surface contaminated by the animal's saliva, blood, urine, nasal secretions, feces, or other bodily fluids.

a. Enteric (intestinal) diseases

In 2012, a group of investigators estimated the burden of enteric illness attributable to animal contact in the United States.[13] The pathogens included in that study were *Campylobacter* spp, *Cryptosporidium* spp, nontyphoidal *Salmonella enterica*, STEC O157:H7, non–O157 STEC strains, *Listeria monocytogenes,* and *Yersinia enterocolitica*. The investigators estimated that 445,213 illnesses, 4,933 hospitalizations, and 76 deaths caused by these pathogens occurred annually as a result of animal contact in all (ie, private and public) settings. Pathogens with the highest proportion of cases attributable to animal contact were *Campylobacter* spp (17%), *Cryptosporidium* spp (16%), nontyphoidal *S enterica* (11%), non–O157 STEC strains (8%), and STEC O157:H7 (6%).

Enteric bacteria and parasites pose the highest risk for human disease from animals in public settings.[14] Enteric disease outbreaks among visitors to fairs, farms, petting zoos, and other public settings are well documented.[15–40] Cattle, sheep, or goats[15,17,20,21,26–28,30,31,34,36,38,40] have typically been identified as sources for infection; however, live poultry,[16,41–48] rodents,[49–53] reptiles,[33,54–60] amphibians,[61] and other domestic[4,62,63] and wild[4] animals also are established sources. Animals that appear healthy can carry pathogens that cause illness in people. A small number of pathogens is often enough to cause illness.[64–68]

Outbreaks as well as sporadic infections with nontyphoidal *S enterica* have been associated with animal contact. Animals that present a high risk for human *Salmonella* spp infections and have been implicated as sources of outbreaks of human illness include poultry (eg, chicks, chickens, and ducklings)[16,41–48,69–72]; reptiles (eg, turtles, snakes, or lizards)[33,54–60,73–80]; and amphibians, especially frogs.[61,81–83] From 1990 through 2014, 53 disease outbreaks linked to live poultry in the United States have been documented.[16,43,69,84] Some of the ill persons in those outbreaks reported contact with live poultry at feed stores,[16,43,69] schools or daycare facilities,[16,41,69] fairs,[69] petting zoos,[69] and nursing homes (CDC, unpublished data, 2010). Since 2014, an additional 14 outbreaks and approximately 1,200 cases of illness associated with exposure to live poultry have been documented (CDC, unpublished data, 2017). Preventive measures at the hatchery level and in agricultural feed stores, along with proper handling of live poultry by poultry owners, can help prevent salmonellosis.[42]

Reptiles and amphibians can carry *Salmonella* spp and have been linked to numer-

ous outbreaks of human illness. Despite laws banning their sale or distribution in the United States, small turtles (those with shells that measure < 4 inches long) continue to be distributed. From 2006 through 2014, 15 multistate outbreaks of salmonellosis, comprising 921 reported illnesses (including a fatal case in an infant), have been linked to contact with small turtles and their habitats.[56] *Salmonella* Typhimurium infections have been linked to contact with African dwarf frogs (an aquatic amphibian), their habitats, or water from their habitats. Ill people included those who reported acquiring frogs at carnivals, pet stores, and other retail stores.[61,82] Activities associated with increased risk of zoonotic disease transmission from turtles, frogs, and other aquatic animals include direct and indirect contact with the animal, tank, water, filtration equipment, or other tank contents. These findings have implications for risk of infection from aquatic exhibits (eg, aquariums and aquatic touch tanks).

Other animals associated with outbreaks of *Salmonella* spp infections in people include hedgehogs[63,85] and rodents such as hamsters, mice, and guinea pigs.[49–53] In all animal species that might harbor *Salmonella* organisms, it is possible for animals that appear healthy and clean to carry and shed the bacteria in their excreta, which can contaminate their fur, hair, feathers, scales, or skin. *Salmonella* spp can also be present in environments where animals or animal excreta, fur, hair, feathers, scales, or skin are present (eg, barns, petting zoos, school classrooms, and pet stores). Pet food and treats, which may be present in public settings such as pet stores, fairs, and school classrooms, have been confirmed as sources of human salmonellosis in several instances.[86–92]

Case-control studies[79,93–96] also have associated sporadic enteric infections (ie, those not linked to an outbreak) with animals including reptiles, amphibians, farm animals, and cats. For example, a study[95] of sporadic *Escherichia coli* O157:H7 infections in the United States determined that people who became ill were more likely to have visited a farm with cows than were people who did not become ill. Other investigations identified associations between *E coli* O157:H7 infection and visiting a farm[97] or living in a rural area.[98] Results of studies[99,100] of cryptosporidiosis in people found that contact with cattle is a risk factor for infection. Another study[101] identified consumption of raw milk and contact with farm animals among the factors associated with *Campylobacter* infection.

(1) Animals shedding enteric pathogens. Animals carrying human enteric pathogens frequently have no signs of illness but can still shed the organisms in feces.[102] Removing ill animals, especially those with diarrhea, from public contact is necessary, but this step alone is not sufficient to protect the health of people and other animals. The fact that some pathogens can be shed intermittently and survive for months or years in the environment,[103–107] as well as the limitations of laboratory testing, makes attempts to identify and remove infected animals unreliable as means of eliminating the risk for transmission. Antimicrobial treatment cannot reliably eliminate infection or prevent shedding, and it does not protect against reinfection. Antimicrobial use in animals can also prolong shedding and contribute to antimicrobial resistance.[108–110]

Disease transmission at animal exhibits can be influenced by multiple factors. Stress induced by transportation, confinement, physical crowding, and increased handling increases the likelihood of animals shedding pathogens.[111–117] Commingling increases the probability that the shed pathogens will infect other animals.[118] Young animals, which are frequently included in settings such as petting zoos, farm visits, and educational programs for children, have a higher prevalence of shedding enteric pathogens such as *E coli* O157:H7 than do mature animals.[119–121] Animal shedding of *E coli* O157:H7 and *Salmonella* organisms is highest in the summer and fall,[116,121] when traveling animal exhibits, agricultural fairs, and farm or petting zoo visits are commonly scheduled.

(2) Transmission of enteric pathogens to people. Enteric pathogens are primarily transmitted by the fecal-oral route. Because animal fur, hair, feathers, scales, skin, and saliva harbor fecal organisms,[122] transmission can occur when people pet, touch, feed, or are licked by animals. Exposure to contaminated materials such as animal bedding, environmental surfaces, clothing, and shoes has also been associated with transmission of pathogens.[29,33,35,82,123,124] In addition, illness has resulted from fecal contamination of food,[24,125] unpasteurized juice,[126] unpasteurized milk,[19,127–130] and drinking water.[131–134]

Young children (ie, < 5 years of age) are considered to be at greater risk for acquiring enteric pathogens from animals than most adults are. One study[135] found that certain risk behaviors for disease transmission such as physical contact with animals

and hand-to-face contact were more common in children than in adults during petting zoo visits. In addition, young children, elderly adults, and people with weakened immune systems have an increased risk for developing severe illness, compared with healthy individuals outside these groups, when they do become infected.[136] Finally, attendees or visitors to animal venues are not the only persons potentially exposed to pathogens; livestock exhibitors have also become infected with *E coli* O157:H7 in outbreaks at fairs.[35]

(3) Environmental exposures to enteric pathogens. Disease transmission can occur in the absence of direct animal contact if a pathogen is present in the environment. Outbreaks of enteric illness have been associated with exposure to environments after animals were removed,[137] dust in the environment,[124] touching or stepping in manure,[32] and falling down or sitting on the ground in a petting zoo.[32] Ill people have also reported having contact with manure on a fence without having touched an animal.[22] In an outbreak of *E coli* O157:H7 in 2004, the outbreak strain was isolated from shavings collected from a baby stroller and from the shoes of petting zoo visitors.[32]

Enteric pathogens can persist in contaminated environments for long periods. For example, *E coli* O157:H7 can survive in soil for months.[22,35,102,103,105,107,124,a] In a 2009 *E coli* O157:H7 outbreak associated with rodeo attendance, the outbreak strain was isolated from the rodeo grounds 90 days after the end of the event.[22] Other outbreaks have also demonstrated long environmental persistence of pathogens, including *E coli* O157:H7 recovered from sawdust on the floor of an animal barn up to 42 weeks after a fair.[124]

b. Internal parasites

Animal parasites can infect people who ingest materials contaminated with animal feces or who ingest or otherwise come into contact with contaminated soil. Exposure to parasites in public settings has led to outbreaks including toxoplasmosis at a riding stable[138,139] and cutaneous larva migrans at a children's camp.[140] The presence of *Toxocara* eggs in public parks indicates a potential risk of toxocariasis to people in public settings.[141–143] Exposure to *Baylisascaris procyonis*, raccoon roundworms, in public settings is also possible; a kinkajou purchased from a pet store was found to be infected with *B procyonis*,[144] and antibodies to *B procyonis* were detected in 7% of a sample of wildlife rehabilitators from the United States and Canada.[145]

c. Animal bites and scratches

(1) Rabies. People who have contact with rabid mammals can be exposed to rabies virus through a bite or when mucous membranes or open wounds become contaminated with infected saliva or nervous tissue. Although no human deaths due to rabies incurred through animal contact in public settings have been reported in the United States, multiple rabies exposures have occurred, requiring extensive public health investigations and medical follow-up. Thousands of people have received rabies postexposure prophylaxis after being exposed to rabid or potentially rabid animals or animal carcasses. Animals involved in reported exposures have included bats, raccoons, cats, goats, bears, sheep, horses, foxes, and dogs, at various venues: an urban public park,[146] a pet store,[147] a county fair,[62,148] petting zoos,[149,150] schools,[62] rodeo events,[62] a horse show,[151] and summer camps.[152] Important public health and medical care challenges associated with potential mass rabies exposures include difficulty in identifying and contacting individuals who are potentially at risk, correctly assessing exposure risks, and providing timely medical prophylaxis when indicated. Human infection with rabies virus is almost always fatal once clinical signs of rabies appear, and prompt assessment and appropriate treatment are critical.[153]

(2) Other bite-related and scratch-related infections. Infections from animal bites and scratches are common; some may require extensive treatment or hospitalization. Bacterial pathogens associated with animal bites include *Pasteurella* spp, *Francisella tularensis*,[154,155] *Staphylococcus* spp, *Streptococcus* spp, *Capnocytophaga canimorsus, Bartonella henselae* (the etiologic agent of cat scratch disease), and *Streptobacillus moniliformis* (the etiologic agent of rat bite fever).[156] Some monkey species (especially macaques) can be infected with B virus (formerly known as cercopithecine herpesvirus 1). Infected monkeys may have no clinical signs or have mild oral lesions; however, fatal meningoencephalitis has been reported in human patients infected through monkey bites or by exposure to bodily fluids.[157,158]

d. Skin infections

Skin contact with animals in public settings can also result in human infection. Cases of ringworm have been reported among animal exhibitors.[159] Infection with parapox virus (the causative agent of contagious ecthyma, also described as orf or sore mouth in sheep and goats) has developed in children after con-

tact with sheep in a public setting.[160] Transmission of pox viruses to people in public settings also has been described, including cowpox virus in a circus animal keeper,[161] cowpox virus in people who handled pet rats at a pet store,[162] and monkeypox among people who contacted infected prairie dogs at a childcare center.[163,164] Contact with aquatic animals and their environment has also been implicated in cutaneous infections,[165] such as *Mycobacterium marinum* infections in people who owned or had cleaned fish tanks.[166,167]

e. External parasites

Ectoparasites and endoparasites can be spread to people who interact with exhibit animals. Sarcoptes scabiei is a skin mite with different host-specific variants that infest people and animals, including swine, dogs, cats, foxes, cattle, and coyotes.[168,169] Although human infestation by animal variants is self-limiting, skin irritation and itching might occur for multiple days and can be difficult to diagnose.[169,170] Bites from avian mites have also been reported in association with gerbils in schoolrooms.[171] Ectoparasite control should be considered in animals in public settings to reduce the risk of human exposure to flea and tick-borne diseases.

2. Diseases transmitted through droplets or aerosols

Generation of infectious droplets or aerosols and subsequent contamination of the environment is an important risk for indirect transmission of disease in public settings. These droplets or aerosols can include infectious agents from animals' respiratory tracts, reproductive fluids, or other sources. Cleaning procedures (eg, pressure washing[10,172]) or dust raised in animal environments, including dust generated from activities such as sweeping and leaf blowing, can lead to infectious aerosols in the immediate environment and surrounding areas.

a. Influenza

Transmission of influenza A viruses between people and animals has increasingly important implications for human-animal interactions in public settings. Influenza viruses that normally circulate in pigs are called variant viruses when they are found in people.[173] Although pigs with influenza can become ill, it has also been shown that apparently healthy pigs can carry influenza viruses.[174] Sporadic cases and small clusters of human infections with variant influenza viruses have been reported since the 1970s[175,176]; most of these cases were associated with direct or indirect exposure to swine at agricultural fairs.[177–179] From July 2011 through October 2012, > 300 confirmed infections with influenza A (H3N2) variant viruses were reported across 10 states.[174,180–184] Most infections occurred in children who reported direct contact with swine at agricultural fairs. Although viruses that normally circulate in birds (avian influenza A viruses) usually do not infect humans, rare cases of human infection with these viruses have been reported.[185] Transmission of human influenza viruses from people to swine[186,187] and other species also has been reported. For example, in 1998, a new strain of influenza A (H3N2) virus derived from human, avian, and classical swine influenza A viruses emerged and became established in swine.[188]

b. Tuberculosis

Tuberculosis can be a concern in certain animal settings; however, the risk is primarily for close contacts, including handlers, of certain animal species,[189–191] particularly elephants.[192,193] Guidelines have been developed regarding removal of tuberculosis-infected animals from public settings.[194]

c. Q fever

Live-birthing exhibits, usually involving cattle, pigs, goats, or sheep, are popular at agricultural fairs and farm visits. Although members of the public do not typically have direct contact with animals during birthing, contact with newborn animals and their dams may occur afterward. Numerous cases of illness related to Q fever have been linked to viewing of animal births.[195,b] Leptospirosis, listeriosis, brucellosis, and chlamydiosis are other serious zoonotic diseases that can be acquired through contact with aborted fetuses, newborn animals, reproductive tissues, or associated fluids.[67]

The causative agent of Q fever is the *Coxiella burnetii* bacterium; goats, sheep, and cattle are the most frequently implicated animal sources of human infections in the United States.[196] Although *C burnetii* infection can cause abortion in animals, it is often subclinical. High numbers of organisms shed in reproductive tissues, and fluids can become aerosolized during birthing, and inhalation of aerosolized organisms can lead to infection in people. Most individuals exposed to *C burnetii* develop an asymptomatic infection, but clinically apparent illness can range from an acute influenza-like illness to life-threatening endocarditis, as well as premature birth, stillbirth, and miscarriage in pregnant women.[197] In 1999, an outbreak of Q fever involving 95 confirmed cases of the disease and 41 hospitalizations was linked to goats and sheep giving birth at petting zoos in indoor shopping malls in Canada.[b] Another Q fever outbreak, in which > 30 human cases were reported in the Netherlands, was associated with public lamb-viewing days at a sheep farm in 2009.[195]

d. *Chlamydophila psittaci* infections

Chlamydophila psittaci infections are usually acquired from psittacine birds and cause respiratory disease in people.[198] Cases of human psittacosis have occurred among staff members at a zoological garden,[199] among people exposed to an aviary in a church,[200] and among pet store staff and visitors.[39] On rare occasions, chlamydial infections acquired from sheep and birds have resulted in human maternal and fetal illness and death.[201–204]

3. Factors influencing the risk of zoonotic disease transmission

a. Handwashing

Handwashing following contact with animals has been associated with decreased rates of illness during disease outbreaks associated with animals in public settings. The CDC was prompted to establish recommendations for enteric disease prevention associated with farm animal contact after 2 outbreaks of *E coli* O157:H7 infections in 2000 in Pennsylvania and Washington.[205] Risk factors identified in the Pennsylvania outbreak were contact with cattle and inadequate handwashing. It was found that handwashing facilities were limited and not configured for children.[36]

In 1996, an outbreak of salmonellosis at a Colorado zoo resulted in 65 cases of the disease (primarily among children) associated with touching a wooden barrier around a temporary Komodo dragon exhibit. Children who were not ill were significantly more likely to have washed their hands after visiting the exhibit than children who were ill.[33]

In a 2005 Florida outbreak of *E coli* O157:H7 infections,[25] both direct animal contact and contact with sawdust or shavings were associated with illness. The likelihood of illness was higher for people who reported feeding animals and lower for those who reported washing their hands before eating or drinking, compared with those who did not. Creating a lather decreased the likelihood of illness for individuals who used soap and water for handwashing; however, drying hands on clothing increased the likelihood of illness.[c]

In 2 outbreaks of infection with multiple enteric pathogens that took place in 2000 through 2001 at a Minnesota children's farm day camp, washing hands with soap after touching a calf and washing hands before going home were associated with decreased likelihood for illness.[27] Risk factors for children who became ill included caring for an ill calf and getting a visible amount of manure on their hands.

Interventions that have been shown to improve hand hygiene compliance include having venue staff provide verbal reminders about hand hygiene to guests before they leave the animal area, use of larger signs with more prominent messages combined with staff actively offering hand sanitizer to visitors,[206] and having a staff member present within or at the exit to the animal contact area.[207] Although the use of hand sanitizers (with an alcohol concentration of 60% to 95%) can be effective at killing pathogens, it should be noted that washing hands with soap and water is still preferred because hand sanitizers do not work equally well for all classes of pathogens and might not work well when hands are heavily soiled or greasy.[208]

b. Facility design

The layout and maintenance of facilities and animal exhibits can increase or decrease the risk for infections.[209] Factors that increase this risk include inadequate handwashing facilities,[62] inappropriate flow of visitors, and incomplete separation between animal exhibits and food preparation and consumption areas.[29,38,210] Other factors include structural deficiencies associated with temporary food service facilities, contaminated or inadequately maintained drinking water systems, and poorly managed sewage or manure containment and disposal processes.[33,124,132–134,211] In one of the largest waterborne disease outbreaks in the United States (1999),[132,133] approximately 800 suspected cases of infection with *E coli* O157:H7, *Campylobacter* spp, or both were identified among attendees at a New York county fair. In that outbreak, unchlorinated water supplied by a shallow well was used by food vendors to make beverages and ice.[133]

Temporary and seasonal animal exhibits and activities are particularly vulnerable to design flaws.[25,33] Animal displays or petting zoos added to attract visitors to zoos, festivals, roadside attractions, farm stands, farms where people can pick their own produce, feed stores, and Christmas tree lots are examples of these types of exhibits. In 2004 and 2005, separate outbreaks of *E coli* O157 occurred at seasonal state fairs in North Carolina and Florida. Both of these outbreaks involved exposure to vendor-run temporary petting zoos.[25] Inadequate handwashing facilities were reported for a temporary exhibit in British Columbia, Canada, where childcare facility and school field trips to a pumpkin patch with a petting zoo resulted in *E coli* O157:H7 infections.[38] Running water and signs recommending handwashing were not available, and alcohol-containing hand sanitizers were placed at a height that was unreachable for some children.

Venues not designed for or accustomed to public events, such as working farms, wildlife rehabilitation facilities, animal adoption events, and animal shelters, might be less likely to have facilities adequately designed to accommodate visitors and to reduce the risk of exposure to zoonotic disease agents. Limitations that might lead to increased infection risk include lack of or inadequate handwashing stations and dedicated food service areas and inappropriate traffic flow patterns. Public access to animal waste areas in these venues might also be problematic.[137]

c. Food contamination

Contamination of food products or food preparation areas secondary to animal contact has previously resulted in outbreaks. Food products contaminated with zoonotic pathogens have included unpasteurized apple cider,[126] produce,[24] and raw milk.[19,62] Contamination from inadequate sanitation (eg, of hands, utensils, or equipment) can occur during food preparation or consumption. Venues in which food contamination contributed to human illness include summer camps[24] and an apple orchard.[d] Large, multistate foodborne outbreaks of salmonellosis have been attributed to food preparers having had contact with live poultry prior to handling food products and subsequently contaminating those products.[16,212] Additionally, consumption of food in an animal environment has been associated with illnesses. In a 2015 outbreak of *E coli* O157:H7 infections at a dairy event in Washington, crude attack rates were higher for individuals who were involved in activities where food was served in an animal barn.[137] Purchase of food at a farm visit[205] and the consumption of sticky foods[125] (eg, ice cream and cotton candy) have also been associated with *E coli* O157:H7–related illnesses.

d. Other factors influencing disease transmission

Events at which people have prolonged close contact with animals, such as day camps and livestock exhibitions, pose a unique challenge with regard to disease prevention. Examples of events where prolonged contact has led to illness include an outbreak of *E coli* O157:H7 infections that occurred at a day camp where prolonged contact with livestock was encouraged.[213]

Failure to properly implement disease-prevention recommendations has also contributed to recurrent outbreaks. Following an outbreak of cryptosporidiosis with 31 ill students at an educational farm program in Minnesota, specific recommendations (including use of coveralls and rubber boots when handling calves, supervised handwashing, and provision of hand sanitizer) were provided to teachers but were inadequately implemented.[31] A subsequent outbreak occurred several months later, with 37 additional illnesses.[31] Handwashing facilities and procedures were still inadequate, and coveralls and boots that were used were found to be dirty, cleaned infrequently, and handled without subsequent handwashing.

Other disease outbreaks have resulted from contaminated animal products used during school activities. Salmonellosis outbreaks associated with dissection of owl pellets in classes have occurred[214]; in 1 such outbreak, risk factors for infection included inadequate handwashing, use of food service areas for the activity, and improper cleaning of contact surfaces. Students in a middle school science class were among those infected in a multistate salmonellosis outbreak associated with frozen rodents sold as snake food.[51]

B. Physical injuries caused by animals in public settings

Although infectious diseases are the most commonly reported health problems associated with animals in public settings, injuries caused by animals are also commonly reported, and these can result in infection as well as trauma. For example, dog bites are an important community problem for which specific guidelines have been written.[215] Injuries associated with animals in public settings include bites, kicks, falls, scratches, stings, crushing of extremities, and being pinned between an animal and a fixed object. Serious and fatal injuries have been associated with various venues and species including commercial stables (interaction with horses),[216] animal sanctuaries (tigers),[217] petting zoos (llamas),[218] photo opportunities (tigers and bison),[217,219] schools (snakes),[220] animal safaris (camels),[221] and dog parks (dogs).[222]

IV. Recommendations for Disease Prevention

A. Overview

Information, publications, and reports from multiple organizations were used to create the recommendations in this document.[223–225] Although no US federal laws address the risk for transmission of pathogens at venues where animals and the public come into contact, some states regulate actions such as the provision of handwashing stations in some or all such settings.[226,227]

Certain federal agencies and associations in the United States have developed standards, recommendations, and guidelines for reducing health risks associated with animal contact by the public. The Association of Zoos and Aquariums has accreditation standards requiring training of staff on the risks of zoonotic diseases, including those associated with public contact.[228] The USDA licenses and inspects

certain animal exhibits in accordance with the Animal Welfare Act[229]; although these inspections primarily address humane treatment of animals, they also impact animal health and public safety. In 2001, the CDC issued recommendations to reduce the risk of infection with enteric pathogens associated with farm visits.[205] The CDC has also issued recommendations for preventing transmission of *Salmonella* spp from reptiles, amphibians, and live poultry to people[69,71,74,76,82,230] and provides educational posters in English and other languages online.[231] The Association for Professionals in Infection Control and Epidemiology and the Animal-Assisted Interventions Working Group have developed guidelines to address risks associated with the use of animals in health-care settings.[8,11] The NASPHV has developed guidance and compendia of measures to reduce risks for human exposure to *C psittaci*, rabies virus, *C burnetii*, novel influenza A viruses, and zoonotic pathogens that veterinary personnel might be exposed to in an occupational setting.[10,198,232–234]

Studies[135,206,207,235] in multiple localities have suggested that the recommendations provided in the present compendium are not completely implemented by members of the public and managers or employees of animal contact venues. Stakeholders should strive to achieve comprehensive implementation of the recommendations in this compendium, to help ensure that visitors can stay healthy and reduce the risk of zoonotic disease transmission while enjoying animals.

B. Applicable venues

The recommendations in this report were developed for settings in which direct animal contact is possible. These settings include farm visits, agritourism venues, petting zoos, school field trips, camps, agricultural fairs, feed stores, wildlife sanctuaries, animal swap meets, childcare centers and schools, and other settings. Contact with animals in public settings should only occur where measures are in place to reduce the potential for disease transmission or injuries. Incidents or problems should be investigated, documented, and reported.

C. Recommendations for local, state, and federal agencies

Agencies should encourage or require oversight to ensure compliance with recommendations at animal contact venues. The recommendations should be tailored to specific settings and incorporated into best practices, protocols, and regulations developed at the state or local level. Additional research should be conducted regarding the risk factors and effective prevention and control methods for health issues associated with animal contact. Additionally, communication and cooperation to ensure public health and safety extends beyond human, animal, and environmental health agencies and should include additional stakeholders such as professional associations, schools, private companies, and industry groups.

1. Dissemination of recommendations

This compendium should be disseminated to cooperative extension personnel, venue operators, farms that host public events, veterinarians, schools and daycares, associations and industry groups, and others associated with managing animals in public settings. Development of a complete list of public animal contact venues within a jurisdiction is encouraged to facilitate dissemination of these recommendations. Agencies should disseminate educational and training materials to venue operators and other stakeholders. Sample materials are available in a variety of media in the NASPHV Animals in Public Settings Toolkit, which is available electronically (www.nasphv.org/documentsCompendiumAnimals.html and www.cdc.gov/healthypets/specific-groups/contact-animals-public-settings.html).[236]

2. Investigating and reporting outbreaks

To evaluate and improve these recommendations, surveillance activities for human infections associated with animal contact should be enhanced. Agencies should take the following steps:

- Conduct thorough epidemiological investigations of outbreaks using a one-health approach across human, animal, and environmental health sectors.
- Follow appropriate protocols for collection and laboratory testing of samples from people, animals, and the environment, including molecular subtyping of pathogen isolates.
- Include questions on disease report forms and outbreak investigation questionnaires about exposure to animals and their environments, products, and feed.
- Report outbreaks to state public health departments.
- Local and state public health departments should also report all outbreaks of enteric infections resulting from animal contact to the CDC through the National Outbreak Reporting System (www.cdc.gov/nors/).

D. Recommendations for animal exhibitors and venue operators

Staff and visitor education, attention to hygiene, and appropriate facility design as well as proper care and monitoring of animals and their enclosures are essential components for reduction of risks associated with animal contact in public settings. It is important to be aware of and follow local, state, and federal regulations regarding animals in public settings.

1. Education

Awareness of zoonotic disease risk is protective against illness in outbreaks.[32] Therefore, educating visitors to public animal contact venues about the risk for transmission of diseases from animals to humans is a potential disease-preven-

tion measure. Education is important not only at traditional animal venues like petting zoos, but also at farms and other venues where live animals are sold or distributed to the public. Even in well-designed venues with operators who are aware of the risks for disease, outbreaks and injuries can occur when visitors do not understand the risks and therefore are less likely to apply disease-prevention measures. Mail-order hatcheries, agricultural feed stores, and other venues that sell or display live poultry should provide health-related information to owners and potential owners. This should include information about the risk of acquiring *Salmonella* infection from contact with live poultry and measures to prevent such infections. Other venues that sell live animals, such as pet stores, should also provide educational materials to customers about the risk of illness and prevention of zoonotic infections. This is especially important for animals considered to have a high risk of transmitting disease to humans (eg, reptiles, amphibians, and live poultry). Evidence-based prevention messages and free educational materials are available in multiple formats and in multiple languages on the CDC Healthy Pets, Healthy People website (www.cdc.gov/healthypets/).

a. Operators and staff

Operators and staff should be aware that certain populations are more likely than others to develop serious illness from pathogens transmitted in animal contact settings. The risk of infection leading to serious illness is particularly high in children < 5 years of age. Other groups that have an increased degree of risk include people with waning immunity (eg, individuals ≥ 65 years of age), pregnant women, or people who are immunocompromised (eg, those with HIV-AIDS, without a functioning spleen, or receiving immunosuppressive treatments). Individuals considered to be at high risk for serious illness should take heightened precautions or avoid animal exhibits. In addition to thorough and frequent handwashing, heightened precautions could include avoiding contact with animals and their environments.

Venue operators and staff (all individuals involved with animal contact activity in any public setting) should take the following steps for public health and safety:

- Become familiar with and implement the recommendations in this compendium.
- Consult with veterinarians, state and local agencies, and cooperative extension personnel on implementation of the recommendations.
- Become knowledgeable about the risks for disease and injury associated with animals and be able to explain risk-reduction measures to staff members and visitors.
- Be aware of populations at high risk for disease and injury interacting with animals and of the presence of animals that pose a high risk for causing disease and injury within the venue.

Each of the following aspects should be taken into consideration in facility design and operation, educational messaging, and animal care and management:

- Direct public contact with ill animals is inappropriate for any audience.
- Children < 5 years of age should not have direct contact with animals that are considered likely to carry zoonotic pathogens (eg, preweaned calves, reptiles, amphibians, or live poultry).
- Children < 5 years of age are also at high risk for disease and injury from contact with other animals and should be supervised at all times to discourage hand-to-mouth activities (eg, nail biting and thumb sucking), contact with manure, and contact with soiled bedding.
- Individuals ≥ 65 years of age and those with weakened immune systems (eg, people with HIV-AIDS, without a functioning spleen, or receiving immunosuppressive treatment) also have a high risk of developing serious illness from contact with animals carrying zoonotic diseases.
- Pregnant women are at risk of stillbirth, miscarriage, and preterm delivery from certain pathogens that might be present in animal contact settings.
- Direct contact with venomous or otherwise dangerous animals (eg, venomous reptiles, nonhuman primates, or certain carnivores and other rabies reservoir species) should be completely prohibited (***See*** the Animal Care and Management section for more information on these species)
- Live animals, especially reptiles, amphibians, and poultry, should not be given as prizes at fairs, carnivals, or other events.

- Ensure that visitors receive educational messages before entering an exhibit, including information that animals can cause injuries or carry germs that can cause serious illness, along with recommended prevention measures **(Figure 1; Appendix 2[1–3])**.
- Provide information in a simple and easy-to-understand format that is age appropriate and language appropriate.
- Provide information in multiple formats (eg, signs, stickers, handouts, and verbal information) and languages.
- Provide information to people arranging school field trips or classroom exhibits so they can educate participants and parents before the visit.
- Encourage compliance by the public with risk-reduction recommendations, especially compli-

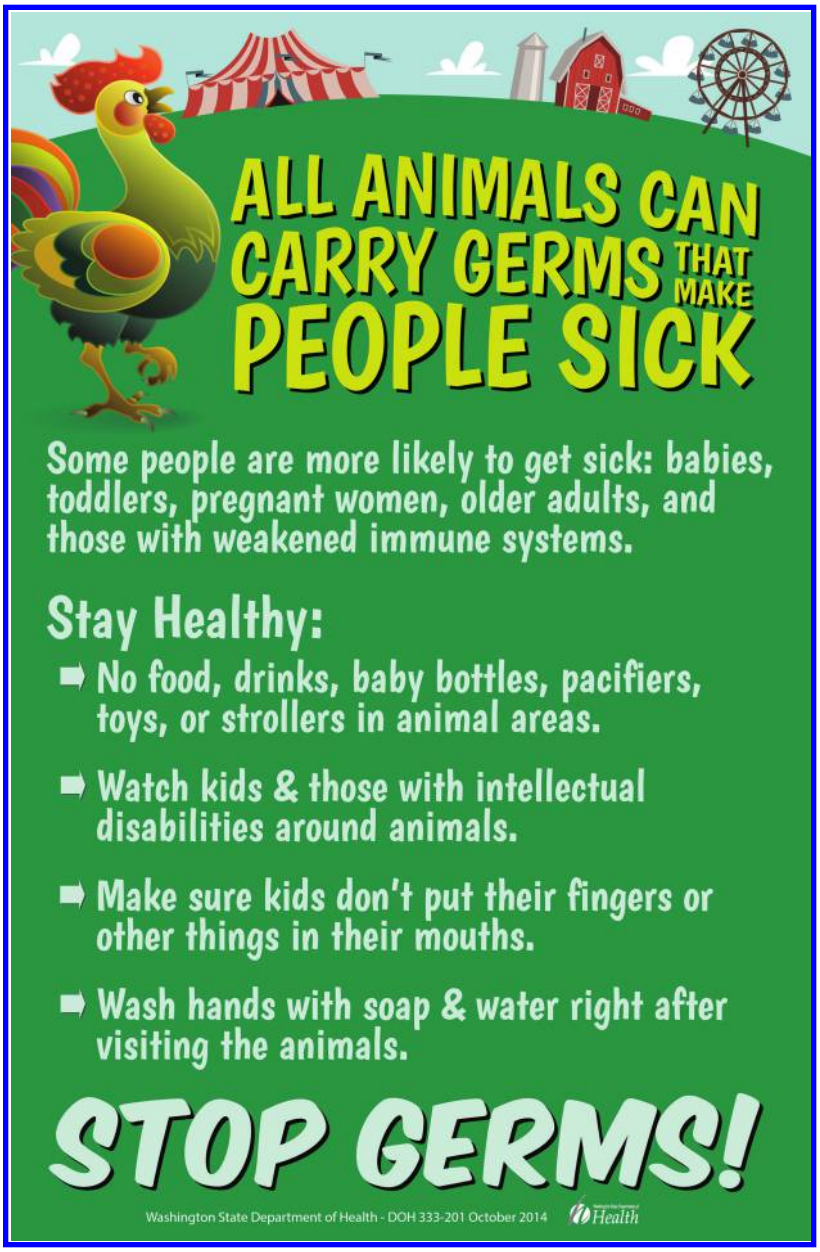

Figure 1—Suggested sign or handout for use in safety education of visitors entering animal areas of petting zoos or other exhibits (available at www.nasphv.org/documentsCompendiumAnimals.html [accessed Sep 14, 2017]).

ance with handwashing procedures as visitors exit animal areas **(Figure 2; Appendix 3)**.[1–3,237]

- Ensure compliance with licensing and registration requirements under the Animal Welfare Act per USDA guidelines for dealers, exhibitors, transporters, and researchers.[229]
- Comply with local and state requirements for reporting animal bites or other injuries.

b. Visitors

Visitors to animal exhibits and those participating in interaction activities of any kind should be presented with effective educational messages aimed at ensuring compliance with the following recommendations:

- Be aware that the risks associated with animal contact are higher among people of certain age groups and health conditions, especially children < 5 years of age, pregnant women, anyone ≥ 65 years of age, and individuals with weakened immune systems, than for others.
- Supervise children properly at all times while in the presence of animals and areas with animal waste; prevent inappropriate contact with animals and sitting or playing on the ground.
- Practice proper hand hygiene, including washing hands immediately upon exit of the animal area and before any hand-to-mouth activity or eating is done.
- Practice proper hand hygiene after any contact with shoes, strollers, or clothing that might have come in contact with animals, their waste, or their bedding.
- Report any animal bites or injuries promptly to the venue operator and to authorities per local or state law.
- Understand that certain diseases shared between animals and people can also pass from people to animals.

2. Facility design and use

Venues should be divided into 3 types of areas: nonanimal areas (where animals are not permitted, with the exception of service animals), transition areas (located at entrances and exits to animal areas), and animal areas (where animal contact is possible or encouraged; **Figure 3**).

a. Layout and traffic patterns

(1) Animal area considerations. The design of facilities and animal pens should minimize the risk associated with animal contact (Figure 3), including limiting direct contact with manure and encouraging handwashing (Appendix 3). The design of facilities or contact settings might include double barriers to prevent contact with animals or contaminated surfaces except in specified animal interaction areas. Contact with fecal material or soiled bedding in animal pens increases risk of exposure to pathogens, and facility designs and policies should limit or prevent this type of exposure, especially to individuals who might be at high risk for infection.

Investigations of previous outbreaks have revealed that temporary exhibits are

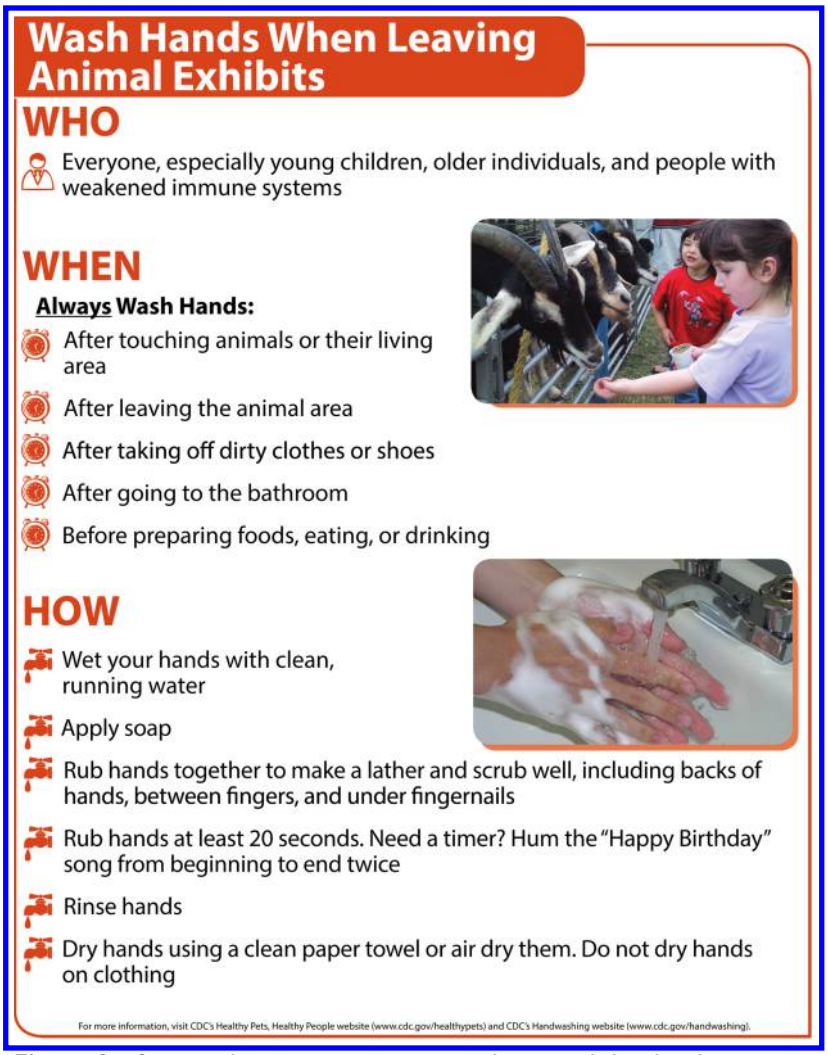

Figure 2—Suggested sign to encourage compliance with handwashing procedures as a means of reducing the possible spread of infectious disease (available in several languages at www.cdc.gov/healthypets/publications/index.html#animal-exhibits-and-handwashing [accessed Jun 30, 2017]).

often not designed appropriately. Common problems include inadequate barriers, floors and other surfaces that are difficult to keep clean and disinfect, insufficient plumbing, lack of signs regarding potential health risks and risk prevention measures, and inadequate handwashing facilities.[25,32,33,125] Specific recommendations might be necessary for certain settings, such as schools and childcare facilities **(Appendix 4[1–3])**.

Recommendations for animal areas are as follows:

- Do not allow consumption of food or beverages in animal areas.
- Do not allow toys, pacifiers, spill-proof cups, baby bottles, strollers or similar items to enter animal areas.
- Prohibit smoking and other tobacco product use in animal areas.
- Children should not be allowed to sit or play on the ground in animal areas or on manure piles. If hands become soiled, supervise handwashing immediately.
- For areas where animal contact is encouraged, a 1-way flow of visitors is recommended, with separate entrance and exit points (Figure 3).
- Control visitor traffic to prevent overcrowding.
- Ensure that animal feed bowls or bins and water are not accessible to the public.
- Allow the public to feed animals only in circumstances where contact with animals is controlled (eg, with barriers).
- Do not provide animal feed in containers that can be eaten by people (eg, ice cream cones) to decrease the possibility of children eating food that has come into contact with animals.
- Promptly remove manure and soiled animal bedding from exhibit areas.
- Assign trained staff members to encourage appropriate human-animal interactions, to identify and reduce potential risks for patrons, and to process reports of injuries and exposures.
- Ensure that visitors do not have access to animals that are not part of the defined interaction area, especially in on-farm visit situations.
- Store animal waste and specific tools for waste removal (eg, shovels and pitchforks) in designated areas that are restricted from public access.
- Avoid transporting manure and soiled bedding through nonanimal areas or transition areas. If this is unavoidable, take precautions to prevent spillage.
- Where feasible, clean and disinfect the animal area (eg, flooring and railings) as necessary.
- Provide adequate ventilation for animals[238] and people, but avoid creating air movement that distributes dust, which may contain contaminants.
- Minimize the use of animal areas for public activities (eg, weddings and dances). If areas previously used for animals must be used for public events, they should be cleaned and disinfected, particularly if food or beverages are served.
- For bird encounter exhibits, refer to the NASPHV's psittacosis compendium[198] for recommendations regarding disease prevention and control.
- Visitors to aquatic touch tank exhibits should

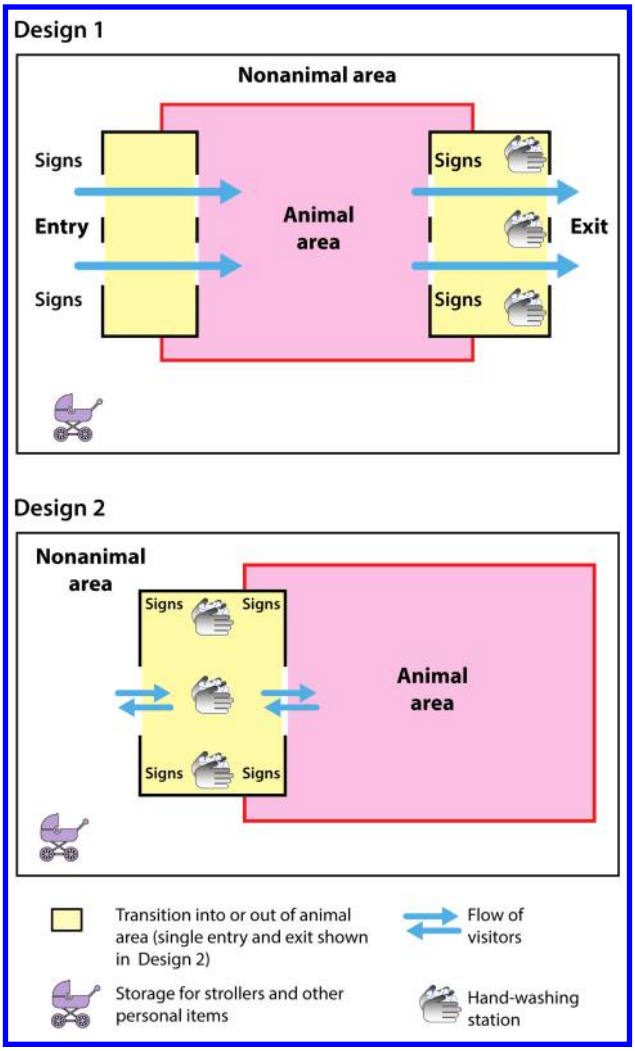

Figure 3—Examples of 2 designs for facilities with animal exhibit areas, including clearly designated animal areas, nonanimal areas, and transition areas with handwashing stations and signs.[1–3] (Adapted from NASPHV Animal Contact Compendium Committee 2013. Compendium of measures to prevent disease associated with animals in public settings, 2013. *J Am Vet Med Assoc* 2013;243:1270–1288. Reprinted with permission.)

be advised not to participate if they have open wounds. Handwashing stations and signs should be provided as for other venues.

- When using animals or animal products (eg, pelts, fecal material, or owl pellets) for educational purposes, use them only in designated animal areas. Animals and animal products should not be brought into school cafeterias or other areas where food and beverages are stored, prepared, served, or consumed.
- When animals are in school classrooms, specific areas must be designated for animal contact (Appendix 4). These areas must be thoroughly cleaned after use. Parents should be informed of the presence of animals as well as the benefits and potential risks associated with animals in school classrooms.
- Immersion exhibits (where members of the public enter into the animal space) present additional opportunities for transmission of infectious agents. Entry into these spaces can lead to increased contamination of clothes, shoes, and other items, therefore increasing risk for disease. Lack of barriers between animals and people also increases the risk for injury. These exhibits heighten the need for supervision and awareness by venue operators and attendees.

(2) Transition area considerations. The following steps are recommended for management of transition areas between nonanimal and animal areas. Establishing transition areas through which visitors pass when entering and exiting animal areas is critical. The transition areas should be designated as clearly as possible, even if they are conceptual rather than physical (Figure 3).

Entrance transition areas should be designed to facilitate education:

- Post signs or otherwise notify visitors that they are entering an animal area and that there are risks associated with animal contact (Figure 1).
- Instruct visitors not to eat, drink, smoke, place their hands in their mouth, or use bottles or pacifiers while in the animal area.
- Establish storage or holding areas for strollers and related items (eg, wagons and diaper bags).

Exit transition areas should be designed to facilitate handwashing (Appendix 3):

- Post signs or otherwise instruct visitors to wash their hands when leaving the animal area (Figure 2).
- Provide accessible handwashing stations for all visitors, including children and people with disabilities (Figure 3).
- Position venue staff members near exits to encourage compliance with proper handwashing.
- Post signs or otherwise instruct visitors to exercise proper handwashing when handling shoes, clothing, and strollers that might have come in contact with animal bedding or waste.

(3) Nonanimal area considerations. Recommendations for nonanimal areas are as follows:

- Do not permit animals, except for service animals, in nonanimal areas.
- Restrict storage, preparation, serving, and consumption of food and beverages to nonanimal areas.

- Provide handwashing facilities and display handwashing signs where food or beverages are served (Figure 2; Appendix 3).
- Separation of food from animal contact areas is of particular importance to farm visit venues; this includes food tasting, distribution of food samples, and consumption of beverages, snacks, or meals.

b. Cleaning and disinfection

Cleaning and disinfection practices should be tailored to the specific situation. For example, most parasitic pathogens, such as *Cryptosporidium parvum*, are resistant to most disinfectants. When a particular organism has been identified, additional guidance regarding specific disinfectants can be found in other resources.[239] General recommendations are that all surfaces should be cleaned thoroughly to remove organic matter before disinfection. Prompt, safe removal of fecal matter reduces the risk of infection. Disinfectants, such as bleach and quaternary ammonium, should be used in accordance with the manufacturer label. Most compounds require > 10 minutes of contact time with a contaminated surface to achieve the desired result. Animals should be removed during the cleaning process and should not reenter the area until after disinfected surfaces have been thoroughly rinsed.

Venue operators should strive to develop an integrated pest management program to eliminate or reduce the risk of exposure to pathogens carried by pests. Carriers of concern include flies, mosquitos, ticks, and fleas as well as rodents.

c. Unpasteurized food and products

Unpasteurized or raw dairy products (eg, milk, cheese, and yogurt) and unpasteurized cider or juices are potential sources of foodborne pathogens. Consumption of such products should be prohibited.

d. Drinking water

Local public health authorities should inspect drinking water systems before use. Only potable water should be used for consumption by animals and people. Backflow prevention devices should be installed between outlets in livestock areas and water lines supplying other areas on the grounds. If the water supply is from a well, adequate distance should be maintained from possible sources of contamination (eg, animal holding areas and manure piles). Maps of the water distribution system should be available for use in identifying potential or actual problems. The use of outdoor hoses should be minimized, and hoses should not be left on the ground. Hoses that are accessible to the public should be labeled to indicate the water is not for human consumption. Operators and managers of facilities in settings where treated municipal water is not available should ensure that a safe water supply (eg, bottled water) is available.

3. Animal care and management

a. Selection of animals for use in public settings

The risk for disease or injury from animal contact can be reduced by carefully managing animal use. The following recommendations should be considered for management of animals in contact with the public:

- Direct contact with some animals is inappropriate in public settings, depending on expected audiences. Use of preweaned calves, reptiles, amphibians, and live poultry (including chicks) is not appropriate in nursing homes, schools, daycares, or other venues where groups at high risk for serious infection are expected to be present; contact with other young ruminants such as lambs or goat kids is also of increased concern in such settings. Animals showing signs of illness are not appropriate for use in public settings. In addition, direct contact with species known to serve as reservoirs for rabies virus (eg, bats, raccoons, skunks, foxes, and coyotes) should not be permitted. Certain nonhuman primates are of particular concern because of the types of pathogens they can transmit to people, such as B virus.[240]
- Because of their strength, unpredictability, or ability to produce venom, certain domestic, exotic, or wild animals should be prohibited from exhibition settings where a reasonable possibility of animal contact exists. Species of primary concern include certain nonhuman primates, certain carnivores (eg, lions, tigers, ocelots, wolves and wolf hybrids, and bears), and venomous species (eg, some reptiles and invertebrates).

b. Routine animal care

Venue operators and staff should monitor animals daily for signs of illness and ensure that animals receive appropriate veterinary care. Ill animals, animals known to be infected with a zoonotic pathogen, and animals from herds with a recent history of abortion, diarrhea, or respiratory disease should not be exhibited. To decrease shedding of pathogens, animals should be housed in a manner to minimize stress and overcrowding.

c. Veterinary care and animal health

Venue operators should retain and use the services of a licensed veterinarian. Regular herd or flock inspection while animals are present in the venue is a critical component of monitoring health. When necessary, Certificates of Veterinary Inspection from an accredited veterinarian should be up-to-date according to local or state requirements for animals in

public settings. Preventive care, including vaccination and parasite control appropriate for the species, should be provided with appropriate input from the herd or flock veterinarian.

(1) Vaccination against rabies virus. All animals should be housed in a manner that reduces potential exposure to wild animals that may serve as rabies virus reservoirs. Mammals should also be up-to-date for rabies vaccinations according to current recommendations.[232] These steps are particularly critical in areas where rabies is endemic and in venues where human-animal contact is encouraged or possible. Because of the extended incubation period for rabies, unvaccinated mammals should be vaccinated ≥ 1 month before they have contact with the public. If no licensed rabies vaccine exists for a particular species (eg, goat, swine, llama, or camel) that is used in a setting where public contact occurs, consultation with a veterinarian regarding extralabel use of rabies vaccine is recommended. A vaccine administered in an extralabel manner does not provide the same degree of assurance as a vaccine labeled for use in a given species; however, extralabel use of rabies vaccine might provide protection for some animals and thus decrease the probability of rabies transmission.[232] Mammals that are too young to be vaccinated should be used in exhibit settings only if additional restrictive measures are available to reduce risks (eg, using only animals that were born to vaccinated mothers and housed in a manner to avoid rabies exposure). In animal contact settings, rabies testing should be considered for animals that die suddenly.

(2) Vaccination against enteric pathogens. While vaccines against certain enteric pathogens (eg, *Salmonella* spp and *E coli* O157:H7) are available for specific animal species, insufficient evidence currently exists to support the use of these products to reduce transmission of disease to people in public settings.[241] More research is necessary and encouraged before firm recommendations can be made.

(3) Other considerations for vaccination. Vaccination of slaughter-class animals before displaying them at fairs might not be feasible because of the slaughter withdrawal period that is needed when certain vaccines are used.

(4) Testing for zoonotic pathogens. Routine screening for zoonotic diseases is not recommended, except for *C psittaci* infection in bird encounter exhibits[198] and tuberculosis in elephants[189] and primates.[242] Screening tests are available for some enteric pathogens (eg, STEC and *Salmonella* spp); however, the interpretation of test results can be problematic. Shedding can be intermittent, and negative results do not indicate an animal was not shedding an organism at an earlier time or will not start shedding in the near future. There is no established guidance for management of animals with positive test results, and inappropriate interpretation might lead to unnecessary treatments, quarantine, or euthanasia.

4. Birthing exhibits

Animal birthing exhibits are increasingly popular. However, it is important for organizers and attendees to understand that animals such as goats, sheep, and cattle giving birth might be shedding pathogens, such as *C burnetii*, *Brucella* spp, *Leptospira* spp, and *L monocytogenes*. Organizers should be aware of the following steps to reduce the risk of disease transmission:

- Ensure that the public has no contact with newly born animals or birthing byproducts (eg, the placenta).
- Ensure that attendees and staff who are particularly vulnerable to zoonotic diseases (eg, pregnant women, people with cardiac valvular disease and other heart conditions, and people with weakened immune systems) and the parents of small children understand the risks of attending or working at these exhibits.
- Thoroughly clean and disinfect the birthing area after each birth, and use appropriate safety precautions and disposal methods for discarding waste products.
- If abortions or stillbirths occur, the exhibit should be closed; operators should work with their veterinarians to determine the cause of abortions or stillbirths.
- Birthing events should be held outdoors or in well-ventilated areas to reduce the risk for human exposure to aerosolized pathogens.

Additional information is available electronically in the CDC fact sheet on Q fever safety at livestock birthing exhibits.[243]

5. Considerations regarding variant influenza

In response to the influenza A (H3N2) variant virus outbreaks associated with swine at agricultural fairs in 2011 through 2012, the following prevention strategies have been recommended[244]:

- All people should take routine preventive actions (eg, practice appropriate hand hygiene) at fairs to reduce potential influenza virus transmission between pigs and people.
- People at high risk of serious influenza-related complications should avoid exposure to pigs at fairs.
- Measures should be taken to reduce the presence of pigs with clinical signs of disease at these events.

Potential strategies to mitigate the risk for intraspecies and interspecies transmission of influenza viruses at agricultural fairs include shortening the swine exhibition period, consulting with a veterinarian to determine whether vaccination of swine against influenza is appropriate, and allowing ≥ 7 days' time between exhibitions before showing a pig or its penmates to reduce the risk of spreading influenza.[244] More detailed and current recommendations for fairs can be found at the NASPHV website.[234]

V. Summary

Contact and interaction with animals in public settings can be a valuable means of education and entertainment. People who provide these opportunities to the public as well as those attending such venues should be aware of the potential health risks associated with such venues and understand that even apparently healthy animals can transmit pathogens. The recommendations included in this compendium will help venue operators, staff, and attendees reduce the risk for injury and zoonotic disease transmission in these settings.

VI. Acknowledgments

The authors thank Kelly Gambino-Shirley, Lauren Stevenson, Valerie Goeman, Natalie Toulme, Rachel Silver, Jennifer Mitchell, and Megin Nichols for their work in revising and updating references and materials in this compendium and Chitrita DebRoy and Megan Jacob for presenting their work on *E coli* screening tests and vaccination to the committee.

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Appendix 1

Selected Zoonotic Diseases of Importance in Public Settings in the United States, 2017.[10]

Disease	Agents	Most common species associated with transmission to people	Most common means of transmission to people	Most common clinical manifestations in people
Acariasis (mite infestation)	*Sarcoptes scabiei* (species-specific variants), *Notoedres cati,* other species of mites	Dogs, cats, horses, goats, sheep, swine, birds	Direct or indirect contact	Itchy skin lesions
Bartonellosis (cat scratch disease)	*Bartonella henselae*, other *Bartonella* spp	Cats	Scratches, bites	Fever, malaise, lymphadenopathy, skin lesions at inoculation site
Brucellosis	*Brucella* spp	Dogs, cervids, feral swine, bison, marine mammals	Ingestion, droplet or aerosol, contact with mucous membranes	Variable, nonspecific febrile illness
Campylobacteriosis	*Campylobacter jejuni,* other *Campylobacter* spp	Poultry, cattle, sheep, goats, swine, dogs, cats, turtles	Fecal-oral contact	Gastroenteritis, fever; usually self-limiting
Capnocytophaga spp infection	*Capnocytophaga canimorsus*, *Capnocytophaga cynodegmi*	Dogs, cats	Scratches, bites	Fever, localized infections
Chlamydiosis (mammalian)	*Chlamydophila abortus*, *Chlamydophila felis*	Sheep, goats, llamas, cats, cattle	Aerosol, fecal-oral contact	Miscarriage, septicemia
Contagious pustular dermatitis (orf)	Parapoxvirus	Sheep, goats	Direct or indirect contact	Skin papules, lymphadenopathy, influenza-like illness
Cryptosporidiosis	*Cryptosporidium parvum*	Cattle (typically calves), sheep, goats	Fecal-oral contact	Gastroenteritis
Cutaneous larva migrans (zoonotic hookworm)	*Ancylostoma braziliense, Ancylostoma caninum*	Dogs, cats	Direct contact with contaminated soil	Skin lesions
Dermatophytosis (ringworm)	*Microsporum* spp, *Trichophyton* spp, *Epidermophyton* spp	Cats, dogs, cattle, goats, sheep, horses, rabbits, rodents, hedgehogs	Direct or indirect contact	Skin lesions
Giardiasis	*Giardia duodenalis*	Dogs, cats, livestock	Fecal-oral contact	Gastroenteritis
Herpes B virus infection	Macacine herpesvirus 1	Macaque monkeys	Bites, scratches	Localized skin lesions, influenza-like symptoms, encephalomyelitis
Influenza	Influenza A virus	Swine, poultry	Droplet or aerosol	Fever, malaise, muscle and joint pain
Leptospirosis	*Leptospira* spp	Swine, cattle, dogs, rodents	Direct or indirect contact, droplet	Fever, other nonspecific signs
Listeriosis	*Listeria monocytogenes*	Cattle, sheep, goats, pigs, dogs, cats	Fecal-oral contact, direct contact	Gastroenteritis, influenza-like symptoms, miscarriage
Monkeypox	Orthopoxvirus	Nonhuman primates, rodents	Direct or indirect contact, bites, aerosol	Influenza-like symptoms followed by skin lesions
Mycobacteriosis (nontuberculous)	*Mycobacterium marinum*	Aquarium fish	Direct contact with infected fish or contaminated water, aerosol	Skin lesions
Pasteurellosis	*Pasteurella multocida* and other species	Dogs, cats, rabbits	Bites, scratches, contact with mucous membranes	Wound infections
Psittacosis	*Chlamydophila psittaci*	Pet birds, poultry	Aerosol	Influenza-like symptoms, cough
Q fever	*Coxiella burnetii*	Goats, sheep, cattle	Aerosol	Influenza-like symptoms, pneumonia (rare), endocarditis
Rabies	Lyssavirus	Domestic and wild mammals	Bites	Acute, progressive neurologic disease
Rat bite fever	*Streptobacillus moniliformis*, *Spirillum minus*	Rats, mice, gerbils	Bites, scratches	Fever, severe muscle and joint pain
Salmonellosis	*Salmonella* spp	Reptiles, amphibians, poultry, swine, cattle, goats, horses, rodents	Fecal-oral contact	Gastroenteritis
Staphylococcosis	*Staphylococcus* spp	Swine, dogs, cats	Bites, scratches	Localized skin and soft tissue infections
STEC infection	STEC	Cattle, goats, sheep, deer	Fecal-oral contact	Gastroenteritis, hemolytic-uremic syndrome
Streptococcosis	*Streptococcus* spp	Swine, dogs, cats	Bites, scratches	Localized skin and soft tissue infections
Toxoplasmosis	*Toxoplasma gondii*	Cats	Fecal-oral contact	Lymphadenopathy, mild influenza-like symptoms
Tuberculosis	*Mycobacterium tuberculosis* complex	Elephants, cattle, nonhuman primates	Aerosol	Respiratory disease
Visceral larva migrans	*Toxocara canis*, *Toxocara cati, Baylisascaris procyonis*	Dogs, cats, raccoons	Fecal-oral contact	Various and nonspecific signs (eg, fever, lethargy, cough)

(Adapted from Williams CJ, Scheftel JM, Elchos BL, et al. Compendium of veterinary standard precautions for zoonotic disease prevention in veterinary personnel: National Association of State Public Health Veterinarians: Veterinary Infection Control Committee 2015. *J Am Vet Med Assoc* 2015;247:1252–1277. Reprinted with permission.)

Appendix 2

Animals in Public Settings: Recommendations for Venue Operators, Staff, and Volunteers[1–3]

All individuals involved with animal contact activity in any public setting should be aware of the following risks for disease and injury associated with animals in public settings:

- Disease and injuries have occurred following contact with animals and their environment.
- Animals that appear healthy can carry harmful germs that can make visitors sick.
- Visitors can pick up harmful germs when they touch animals or animal droppings or enter animal environments (even without directly contacting the animals).
- Visitors can rid themselves of most harmful germs acquired if they wash their hands immediately after leaving an animal area. Visitors should wash their hands even if they did not directly contact the animals.
- The risk for developing serious or life-threatening zoonotic disease from contact with animals is higher for some visitors, especially children < 5 years of age, persons ≥ 65 years of age, pregnant women, and people with weakened immune systems, than for others.
- Direct contact with some animals is inappropriate for some, or all, audiences in public settings.
  - No visitors should have contact with ill animals.
  - Direct contact with preweaned calves, reptiles, amphibians, and live poultry is not appropriate for people at high risk for zoonotic disease transmission, and direct contact with young ruminants of other species (eg, goats and sheep) is of increased concern for these individuals.
  - Dangerous animals (eg, nonhuman primates, certain carnivores, other rabies reservoir species, and venomous reptiles) should be prohibited from having direct contact with the public.
- Live animals, especially reptiles, amphibians, and live poultry, should not be given as prizes at fairs, carnivals, or other events.

Operators and all individuals involved with the animal contact activity should educate visitors (with simple instructions in multiple age-appropriate and language-appropriate formats) about the following before they enter animal areas:

- Risks for disease and injury, including the information that children < 5 years of age, people ≥ 65 years of age, pregnant women, and those with weakened immune systems are at greater risk than others of developing serious zoonotic diseases.
- Handwashing and assisting children with handwashing immediately after visiting an animal area.
- Avoiding eating, drinking, or placing things in their mouths after animal contact or after visiting an animal area, until they have washed their hands.
- Closely supervising children.
- Awareness that objects such as clothing, shoes, and stroller wheels can become soiled and serve as a source of germs after leaving an animal area.

Operators and all individuals involved with the animal contact activity should take the following steps to maintain a safe environment when animals are present in public settings:

- Design the venue with safety in mind by having designated animal areas, nonanimal areas, and transition areas; temporary exhibits and animal interaction areas used in farm visits, agritourism venues, etc may need additional measures to minimize risks of injury or disease transmission.
- Do not permit animals other than service animals in nonanimal areas.
- Assign trained staff members to monitor animal contact areas to ensure visitor safety.
- Exclude food and beverages, toys, pacifiers, spill-proof cups, baby bottles, and smoking and related activities from animal contact areas.
- Keep the animal areas as clean and disinfected as possible, and limit visitor contact with manure and animal bedding.
- Allow feeding of animals only if contact with animals can be controlled (eg, over a barrier), and do not provide feed in containers that might be consumed by persons (eg, ice cream cones).
- Design transition areas for entering and exiting animal areas with appropriate signs or notifications regarding risks associated with animal contact and location of handwashing facilities.
- Maintain handwashing stations that are accessible to children and people with disabilities, and direct visitors to wash their hands immediately upon exiting animal areas.
- Position handwashing stations in places that encourage handwashing when exiting animal areas.
- Maintain handwashing facilities and stations to include routine cleaning and restocking to ensure an adequate supply of paper towels and soap.
- Ensure that animals receive appropriate preventive care, including vaccinations and parasite control appropriate for the species.
- Provide potable water for animals.
- Provide handwashing facilities where food and beverages are stored, prepared, served, or consumed.
- Prohibit consumption of unpasteurized dairy products (eg, raw milk), ciders, and juices.
- Minimize use of animal areas at other times for public activities (eg, weddings, dances, and barbecues).

Handwashing is the most important prevention step for reducing disease transmission associated with animals in public settings.

(Adapted from NASPHV Animal Contact Compendium Committee 2013. Compendium of measures to prevent disease associated with animals in public settings, 2013. *J Am Vet Med Assoc* 2013;243:1270–1288. Reprinted with permission.)

Appendix 3

Handwashing Recommendations to Reduce Disease Transmission From Animals in Public Settings[1–3]

General Recommendations

Handwashing is the most important prevention step for reducing disease transmission associated with animals in public settings. Hands should always be washed immediately when exiting animal areas, even if direct animal contact was not made; handwashing is also important after removing soiled clothing or shoes and before eating, drinking, or handling food. Venue staff members should encourage visitors to wash hands immediately upon exiting animal areas.

Correct Handwashing Procedure

- Wet hands with clean, running water (warm or cold) and apply soap; rub hands together to make a lather and scrub them well (be sure to scrub the backs of hands, between fingers, and under nails); continue rubbing hands for at least 20 seconds; rinse hands well under running water.
- Dry hands with a clean disposable paper towel or air-dry them. Do not dry hands on clothing.
- Assist young children with washing and drying their hands.

Establishment and Maintenance of Handwashing Facilities or Stations

- The number of handwashing facilities or stations should be sufficient for the maximum anticipated attendance, and facilities should be accessible for children (ie, low enough for children to reach or equipped with a stool) and people with disabilities as well as the general population.
- Handwashing facilities and stations should be conveniently located in transition areas between animal and nonanimal areas and in nonanimal food concession areas.
- Maintenance of handwashing facilities and stations should include routine cleaning and restocking to ensure an adequate supply of paper towels and soap.
- Running water should be of sufficient volume and pressure to remove soil from hands. Volume and pressure might be substantially reduced if the water supply is furnished from a holding tank; therefore, a permanent, pressurized water supply is preferable.
- Handwashing stations should be designed so that both hands are free for handwashing by having operation with a foot pedal or water that stays on after hand faucets are turned on.
- Liquid soap dispensed by a hand pump or foot pump is recommended.
- To increase compliance, water temperature should be set at what is considered comfortable.[237]
- Communal basins, in which water is used by more than 1 person at a time, are not adequate handwashing facilities.

Recommendations Regarding Hand-Sanitizing Agents

- Washing hands with soap and water is the best way to reduce the number of germs on them. If soap and water are not available, use an alcohol-based hand sanitizer that contains at least 60% alcohol in the interim until hands can be properly washed.
- Visible contamination and dirt should be removed before using hand sanitizers. Hand sanitizers may not be as effective when hands are visibly dirty or greasy.
- Even when hand sanitizer is used, visitors should always wash hands with soap and water as soon as possible after exiting animal areas; alcohol-based hand sanitizers can quickly reduce the number of germs on hands in some situations, but these products are not effective against all germs.

Correct Use of Hand Sanitizers

- Apply the product to the palm of 1 hand.
- Rub your hands together.
- Rub the product over all surfaces of your hands and fingers until your hands are dry.

Handwashing Sign Recommendations

- At venues where human-animal contact occurs, signs regarding proper handwashing practices are critical to reduce disease transmission.
- Signs that remind visitors to wash hands should be posted at exits from animal areas (ie, exit transition areas) and in nonanimal areas where food is served and consumed.
- Signs should be posted that direct all visitors to handwashing stations when exiting animal areas.
- Signs with proper handwashing instructions should be posted at handwashing stations and in restrooms to encourage proper practices.
- Handwashing signs should be available in multiple age-appropriate and language-appropriate formats.

(Adapted from NASPHV Animal Contact Compendium Committee 2013. Compendium of measures to prevent disease associated with animals in public settings, 2013. *J Am Vet Med Assoc* 2013;243:1270–1288. Reprinted with permission.)

Appendix 4

Guidelines for Exhibition of Animals in School and Childcare Settings[1–3]

General Recommendations

- Animals are effective and valuable teaching aids, but safeguards are required to reduce the risk for infection and injury. Other groups have developed recommendations similar to those provided here.[175,204,205]
- Ensure that teachers and staff know which animal species are inappropriate as residents or visitors to the facility and which animals should not be in direct contact with children (**See** animal-specific recommendations in this Appendix).
- Ensure that personnel providing animals for educational purposes are knowledgeable regarding animal handling and zoonotic disease issues. People or facilities that display animals to the public should be licensed by the USDA.
- Inform parents of the presence of animals as well as the benefits and potential risks associated with animals in school classrooms. Consult with parents to determine special considerations needed for children who are immunocompromised, have allergies, or have asthma.
- Educate children about harmful germs that can spread between animals and people and about proper handwashing technique.
- Wash hands right after contact with animals, animal products, or feed or after being around animal environments.
- Supervise human-animal contact, particularly involving children < 5 years of age.
- Display animals in enclosed cages or under appropriate restraints.
- Do not allow animals used in schools or daycares to roam, fly free, or have contact with wild animals.
- Designate specific areas for animal contact. Do not allow food or drink in animal contact areas; do not allow animals in areas where food and drink are stored, prepared, served, or consumed.
- Clean and disinfect all areas where animals and animal products have been present. Children should perform this task only under adult supervision.
- Do not clean animal cages or enclosures in sinks or other areas used to store, prepare, serve, or consume food and drinks.
- Obtain a certificate of veterinary inspection, proof of rabies vaccination, or both according to local or state requirements for the species being exhibited. Also, ensure veterinary care, including preventive health programs for endoparasites and ectoparasites as appropriate for the species.

Animal-Specific Recommendations

Refer to the general guidelines regarding species for which specific recommendations are not provided in this section (eg, nonpsittacine birds and domestic dogs, cats, rabbits, and rodents [including mice, rats, hamsters, gerbils, guinea pigs, and chinchillas]).

- Reptiles (eg, turtles, snakes, and lizards): Do not keep reptiles in facilities with children < 5 years of age, and do not allow children of this age group to have direct contact with these animals.
- Amphibians (eg, frogs, toads, salamanders, and newts): Do not keep amphibians in facilities with children < 5 years of age, and do not allow children of this age group to have direct contact with these animals.
- Live poultry (eg, chicks, ducklings, and goslings): Do not keep live poultry in facilities with children < 5 years of age, and do not allow children of this age group to have direct contact with these animals.
- Ferrets: Do not keep ferrets in facilities with children < 5 years of age, and do not allow children of this age group to have direct contact with these animals to avoid bites. Ferrets should be up-to-date for rabies vaccination.
- Farm animals: Certain animals (eg, calves, goats, and sheep) intermittently excrete substantial numbers of germs; therefore, these farm animals are not appropriate in facilities with children < 5 years of age and should not be displayed to older children in school settings unless meticulous attention to personal hygiene can be ensured.
- Guide, hearing assistance, or other service animals and trained animals used in law enforcement: These may be used in accordance with recommendations from the sponsoring organizations when they are under the control of a person familiar with the specific animal.
- Psittacine birds (eg, parrots, parakeets, and cockatiels): Consult the psittacosis compendium[198] and seek veterinary advice.
- Fish: Children < 5 years of age and people with weakened immune systems should not clean aquariums. Wash hands before and after cleaning aquariums, and wear gloves if hands have cuts or wounds or when working with rough rocks or spiny fish. Do not dispose of aquarium water in sinks used for food preparation or for obtaining drinking water.
- Animal products: Assume that products such as owl pellets and frozen rodents used to feed reptiles are contaminated with *Salmonella* organisms. Dissection of owl pellets should not be performed in areas where food is stored, prepared, served, or consumed. Children < 5 years of age should not be allowed to have direct contact with animal products unless the product has been treated to eliminate harmful germs.

Animals Not Recommended in School or Childcare Settings

- Inherently dangerous animals (eg, lions, tigers, cougars, and bears).
- Nonhuman primates (eg, monkeys and apes).
- Mammals that pose a high risk for transmitting rabies (eg, bats, raccoons, skunks, foxes, and coyotes).
- Aggressive or unpredictable wild or domestic animals.
- Stray animals with unknown health and vaccination history.
- Venomous or toxin-producing spiders, insects, reptiles, and amphibians.
- Animals that pose a high risk for zoonotic disease transmission (eg, preweaned calves, reptiles, amphibians, and live poultry) or bites (eg, ferrets).

Adapted from NASPHV Animal Contact Compendium Committee 2013. Compendium of measures to prevent disease associated with animals in public settings, 2013. *J Am Vet Med Assoc* 2013;243:1270–1288. Reprinted with permission.)