National Association of State Public Health Veterinarians, Inc.

DATE: April 14, 2006

TO: State Public Health Veterinarians
State Epidemiologists
State Veterinarians
Others Concerned with Disease Associated with Animals in Public Settings

FROM: Millicent Eidson, MA, DVM, DACVPM (Epidemiology)
Jeffrey B. Bender, DVM, MS, DACVPM
Co-Chairs, Compendium Committee

SUBJECT: *Compendium of Measures to Prevent Disease Associated with Animals in Public Settings, 2006*

On behalf of the National Association of State Public Health Veterinarians (NASPHV), we are pleased to announce the availability of the *Compendium of Measures to Prevent Disease Associated with Animals in Public Settings, 2006*. There are many positive benefits of human-animal contact; however, infectious disease outbreaks related to such contacts have been increasingly reported. This Compendium provides standardized recommendations for use by public health officials, veterinarians, animal venue operators, animal exhibitors, and others concerned with disease-control and with minimizing risks associated with animals in public settings.

This Compendium updates the 2005 Compendium that was released in the CDC Morbidity and Mortality Report (MMWR). Due to cost considerations, the 2006 Compendium will not be published in the MMWR. The 2006 Compendium provides the following updates:

- Eight new references have been added from recent publications and disease outbreaks
- Descriptions of recent outbreaks and lessons learned are provided, including the 2005 North Carolina and Florida fair-associated E. coli O157:H7 outbreaks.
- The Recommendations section has been re-organized into bullet format, to provide more clear-cut advice on prevention and control.
- A new appendix has been added (Appendix B), providing a simple one-page handout, "Animal in Public Settings—Information for Visitors". This handout may be helpful for local use, or development of other local information for visitors to animal venues.

We recommend that you distribute this cover memorandum and the Compendium widely to persons responsible for oversight or regulation of animal contact venues, persons who operate such venues, and settings where animal contact may occur. You also may wish to distribute the Appendices as stand-alone handouts, including Appendix A: Hand-Washing Recommendations; Appendix C: Designs for Animal Contact Facilities; and Appendix D: Guidelines for Schools.

If you update any web links to this document, please delete links to prior versions of the Compendium. This Compendium will be available on the web at the NASPHV website: www.nasphv.org, in the Publications section, along with the 2006 Rabies and Chlamydiosis compendia.

This Compendium will be updated again in 2007. Any comments or suggestions for the 2007 Compendium should be sent to Dr. Bender at Veterinary Public Health, University of Minnesota, 1354 Eckles Ave., 136F ABLMS Bldg., St. Paul, Minnesota 55108.

Compendium of Measures to Prevent Disease Associated with Animals in Public Settings, 2006

National Association of State Public Health Veterinarians, Inc. (NASPHV)

SUMMARY

Many venues encourage or permit the public to come in contact with animals, resulting in millions of human-animal contacts each year. These settings include county or state fairs, petting zoos, animal swap meets, pet stores, zoologic institutions, circuses, carnivals, farm tours, livestock-birthing exhibits, educational exhibits at schools, and wildlife photo opportunities. Although multiple benefits of human-animal contact exist, infectious diseases, rabies exposures, injuries, and other human health problems associated with these settings are of concern. Infectious disease outbreaks reported during the previous decade have been caused by *Escherichia coli* O157:H7, *Salmonella*, *Coxiella burnetti*, *Mycobacterium tuberculosis*, ringworm, and other pathogens. Such incidents have substantial medical, public health, legal, and economic effects.

This report provides standardized recommendations for public health officials, veterinarians, animal venue operators, animal exhibitors, visitors to animal venues and exhibits, physicians, and others concerned with disease-control and with minimizing risks associated with animals in public settings. The recommendation to wash hands is the single most important prevention step for reducing the risk for disease transmission. Other critical recommendations are that venues include transition areas between animal areas and nonanimal areas (where food is sold) and that animals are properly cared for and managed.

The NASPHV Committee

Millicent Eidson, MA, DVM, DACVPM (Epid), Cochair
Jeffrey B. Bender, DVM, MS, DACVPM, CoChair
Carina Blackmore, DVM, PhD
John R. Dunn, DVM, PhD
James H. Wright, DVM, MPVM, DACVPM (Epid)

Consultants to the Committee

Frederick J. Angulo, DVM, PhD (Centers for Disease Control and Prevention--CDC)
Sue K. Billings, DVM (National Assembly of State Animal Health Officials)
Margaret A. Davis, DVM, PhD (Washington State University)
James E. Keen, DVM, PhD (U.S. Department of Agriculture)
John P. Huntley, DVM (AVMA Council on Public Health and Regulatory Veterinary Medicine)
John S. Marr, MD (Council of State and Territorial Epidemiologists--CSTE)

Endorsed by: CDC, CSTE, AVMA

Address all correspondence to: J.B. Bender DVM, Co-chair, NASPHV Animal Contact Compendium Committee, University of Minnesota, Veterinary Public Health, 136F Andrew Boss, 1354 Eckles Avenue, St. Paul, MN 55108, Telephone: 612-625-6203; Fax: 612-624-4906; E-mail: bende002@umn.edu.

Compendium of Measures to Prevent Disease Associated with Animals in Public Settings, 2006

National Association of State Public Health Veterinarians, Inc. (NASPHV)

INTRODUCTION

Contact with animals in public settings (e.g., fairs, farm tours, petting zoos, and schools) provides opportunities for entertainment and education concerning animals and animal husbandry. However, inadequate understanding of disease transmission and animal behavior can lead to infectious diseases, rabies exposures, injuries, and other health problems among visitors, especially children, in these settings. Diseases called zoonoses or zoonotic diseases can be transmitted from animals to humans. Of particular concern are situations in which substantial numbers of persons may be exposed to zoonotic disease and become ill. A 2004 review article identified 21 human infectious disease outbreaks associated with animals in public settings during 1990–2000 in the United States (1). Since 2001, 35 additional outbreaks have occurred in the United States that have been reported to the Centers for Disease Control and Prevention. (F. Angulo, CDC, 2006).

The National Association of State Public Health Veterinarians (NASPHV) appreciates the positive benefits of human-animal contact. Although eliminating all risk from animal contacts is not achievable, this report provides recommendations for minimizing disease and injury.

NASPHV recommends that local and state public health, agricultural, environmental, and wildlife agencies, and other organizations use these recommendations to establish their own guidelines or regulations for reducing the risk for disease from human-animal contact in public settings. Multiple venues exist where public contact with animals is permitted (e.g., animal displays, petting zoos, animal swap meets, pet stores, zoological institutions, nature parks, circuses, carnivals, farm tours, livestock-birthing exhibits, county or state fairs, schools, and wildlife photo opportunities). Persons responsible for managing these venues should use the information in this report to reduce risk.

Guidelines to reduce risks for disease from animals in health-care facilities and service animals (e.g., guide dogs) have been developed (2–4). These settings are not specifically addressed in this report, although the general principles and recommendations are applicable.

ENTERIC (INTESTINAL) DISEASES

Infections with enteric bacteria and parasites pose the highest risk for human disease from animals in public settings (5). Healthy animals can harbor human enteric pathogens. Many of these organisms have a low infectious dose (6–8). Because of the popularity of animal venues, a substantial number of persons may be exposed to these organisms. Reports of cases and outbreaks of enteric diseases among visitors to fairs, farms, and petting zoos have been documented. Pathogens linked to outbreaks include Shiga toxin-producing *Escherichia coli*, *Campylobacter, Salmonella*, and *Cryptosporidium* (9–21,

57). Although these reports usually document cattle, sheep, and goats as sources for infection, poultry (22-25), rodents (26), and other domestic and wild animals also are potential sources.

The primary mode of transmission for enteric pathogens is the fecal-oral route. Because animal fur, hair, skin, and saliva (27) can become contaminated with fecal organisms, direct transmission can occur when persons pet, touch, feed, or are licked by animals. Transmission has also occurred from fecal contamination of food, including raw milk (28-30), sticky foods (e.g., cotton candy [31]), and water (32-34). Illness has also been associated with contaminated clothing and shoes (18, 21), and with animal bedding, flooring, barriers, and other environmental surfaces (12, 20, 22, 35-37).

Animals infected with enteric pathogens (e.g., *E. coli* O157:H7, *Salmonella*, and *Campylobacter*) frequently exhibit no signs of illness and can shed pathogens intermittently. Although removing ill animals (especially those with diarrhea) is necessary to protect animal and human health, it is not sufficient. Animals that appear to be healthy can shed pathogens that contaminate the environment. Some pathogens live months or years in the environment (38-42). Because of intermittent shedding and limitations of laboratory tests, culturing fecal specimens or other attempts to identify, screen, and remove infected animals may reduce, but will not eliminate, the risk for transmission. Antimicrobial treatment of animals cannot reliably eliminate infection, shedding of enteric pathogens, or prevent reinfection.

Multiple factors increase the probability of disease transmission at animal exhibits. Animals are more likely to shed pathogens because of stress induced by prolonged transportation, confinement, crowding, and increased handling by people (43-49). Commingling increases the probability that animals shedding organisms will infect other animals (50). The prevalence of certain enteric pathogens is often higher in young animals (51-53), which are frequently exhibited by petting zoos. Shedding of *E. coli* O157:H7 and *Salmonella* is highest in the summer and fall when substantial numbers of traveling animal exhibits, agricultural fairs, and petting zoos are scheduled (49, 54, 55).

The risk for infections or outbreaks is increased by certain human factors and behaviors, especially by children. These factors include lack of awareness of the risk of disease, inadequate hand-washing, a lack of close supervision of children, and hand-to-mouth activities (e.g., use of pacifiers, thumb-sucking, eating). Furthermore, children have increased risk for serious infections and are particularly attracted to animal venues.

The layout and maintenance of facilities and animal exhibits can also contribute to the risk for infection. Risk factors include inadequate hand-washing facilities (1), structural deficiencies associated with temporary food-service facilities (12, 18, 19), inappropriate flow of visitors, and incomplete separation between animal exhibits and food preparation and consumption areas (56). Other factors include contaminated or inadequately maintained drinking water and sewage/manure disposal systems (32-34, 36).

Lessons from Outbreaks

Two *E. coli* O157:H7 outbreaks in Pennsylvania and Washington State prompted CDC to establish recommendations for enteric disease prevention associated with farm animal contact (http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5015a5.htm). Risk factors found in both outbreaks were direct animal contact and inadequate hand-washing (14,16). In the Pennsylvania outbreak, 51 persons (median age: 4 years) became ill within

10 days of visiting a dairy farm. Eight of these case-patients (16%) developed hemolytic uremic syndrome (HUS), a potentially fatal consequence of *E. coli* O157:H7 infection. The same strain of *E. coli* O157:H7 was isolated from cattle, case-patients, and the farm environment. In addition to the reported cases, an increased number of diarrhea cases in the community were attributed to visiting the farm. An assessment of the farm environment determined that no areas existed for eating and drinking that were separate from the animal contact areas, and that the limited hand-washing facilities were not configured for children (14).

The protective effect of hand-washing and the persistence of organisms in the environment were demonstrated in an outbreak of *Salmonella* infections at a Colorado zoo. Sixty-five cases (the majority of them children) were 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. *Salmonella* was isolated from 39 case-patients, a Komodo dragon, and the wooden barrier (12).

During 2000–2001 at a Minnesota children's farm day camp, washing hands with soap after touching a calf and washing hands before going home were protective factors in two outbreaks involving multiple enteric organisms (57). A total of 84 illnesses were documented among attendees. Implicated organisms for the human infections were *E. coli* O157:H7, *Cryptosporidium parvum*, non-O157 Shiga toxin-producing *E. coli* (STEC), S*almonella enterica* serotype Typhimurium, and *Campylobacter jejuni*. These organisms, as well as *Giardia*, were also isolated from the calves. Risk factors for children included caring for an ill calf and getting visible manure on their hands.

Enteric pathogens can contaminate the environment and persist in animal housing areas for long periods of time. For example, *E. coli* O157:H7 can survive in soil for months (36, 38, 40, 58). Prolonged environmental persistence of pathogens was documented in an Ohio outbreak of *E. coli* O157:H7 infections in which 23 persons became ill at a fair after handling sawdust, attending a dance, or eating and drinking in a barn where animals were exhibited during the previous week of the fair. (36). Fourteen weeks after the fair ended, *E. coli* O157:H7 was isolated from multiple environmental sources within the barn, including sawdust on the floor and dust on the rafters. Forty-two weeks after the fair ended, *E. coli* O157:H7 was recovered from sawdust on the floor. In 2004, an outbreak of *E. coli* O157:H7 infection was associated with attendance at the North Carolina State Fair goat and sheep petting zoo (18). Health officials investigated 108 case-patients, including 15 who had HUS. The outbreak strain was isolated from the animal bedding 10 days after the fair was over, and from the soil 5 months after the animal bedding and topsoil were removed (J. Keen, USDA, 2006). In a Texas agricultural fair-associated *E. coli* O157:H7 outbreak with 25 case-patients, including 4 who developed HUS, the same strain isolated from cases was found in environmental samples 46 days after the end of the fair (20).

Transmission may occur even in the absence of direct animal contact if the pathogen is disseminated in the environment. Transmission of *E. coli* O157:H7 from airborne dust was implicated in two outbreaks in Ohio and Oregon (36, 22). In the Oregon county fair outbreak, there were 60 cases, the majority of them children (22). Illness was associated with visiting an exhibition hall that housed goats, sheep, pigs, rabbits, and poultry; but it was not associated with touching animals or their pens, eating, or inadequate hand-

washing. The same organism was recovered from ill persons and the building.

Improper facility design and inadequate maintenance may increase risk, as illustrated by one of the largest waterborne outbreaks in the United States (33, 34). Approximately 800 suspected cases of *E. coli* O157:H7 and *Campylobacter* were identified among attendees at a New York county fair where the water and sewage systems had deficiencies. Temporary facilities may be particularly vulnerable to design flaws (12, 18). An outbreak of two *E. coli* O157:H7 cases in Arizona was associated with a temporary petting zoo at a municipal zoo (18). Temporary venues include those that add an animal display or petting zoo for the purpose of attracting children to zoos, festivals, roadside attractions, farm stands, pick your own produce farms, Christmas tree lots, etc. Daycare and school field trips to a pumpkin patch were associated with 44 cases of *E. coli* O157:H7 in British Columbia (19). The same strain of *E. coli* was found both in children and in a petting zoo goat. Running water and signage recommending hand-washing were not available, and alcohol hand sanitizers were at a height that was unreachable for some children. One hundred sixty-three case patients were ill with Shiga toxin-producing *E. coli* O111:H8 and/or *Cryptosporidium* at a New York farm stand that sold unpasteurized apple cider and had a petting zoo with three calves to attract customers (F. Coronado, CDC, 2006).

Several outbreaks indicate that failure to understand and properly implement disease prevention recommendations can lead to transmission. Following a Minnesota outbreak of cryptosporidiosis with 31 ill students at a school farm program, specific recommendations were provided to the teachers but were inadequately implemented (21). A subsequent outbreak occurred with 37 illnesses. Hand-washing procedures were inadequate (e.g., only water available, crowding at sink, drying hands on clothes). Coveralls and boots were dirty, cleaned infrequently, and removed after hand-washing.

Even in well-designed venues with operators who are aware of the risks of disease, outbreaks can occur. A 2005 Florida *E. coli* O157:H7 outbreak with 63 cases, including 7 who developed HUS, occurred in a fair at which the venue operator had implemented risk reducing measures. Both direct animal contact and indirect contact with sawdust or shavings were associated with illness (18). Persons who reported feeding animals were at increased risk. Among people who washed their hands after leaving the animal area, using soap and water was only protective for people who created a lather (D. Chertow, CDC/Florida Dept. of Health, 2006). Drying hands on clothes increased the risk for illness. Persons were less likely to become ill if they reported washing their hands before eating or drinking, or were aware of the risk of illness before the outbreak.

Sporadic Infections

Through not identified as part of recognized outbreaks, sporadic infections have been associated with animal environments. A case-control study in the Netherlands found an association between *Salmonella* Typhimurium infections and playing in a sandbox (often used by cats as a litterbox) (37). A study of sporadic *E. coli* O157:H7 infections among selected U.S. states and counties determined that case-patients, especially children, were more likely than healthy persons to have visited a farm with cows (59). Additional studies also documented an association between *E. coli* O157:H7 infection and visiting a farm (60) or living in a rural area (61). Studies of human cryptosporidiosis have documented contact with cattle or visiting farms as risk factors for infection (62-64). A

case-control study identified multiple factors, including raw milk consumption and contact with farm animals, associated with *Campylobacter* infection (65). In other studies, farm residents were at a lower risk for infection with *Cryptosporidium* (62) and *E. coli* O157:H7 (66) than farm visitors, presumably because the residents had acquired immunity to the infection as a result of their early and frequent exposure to these organisms. However, livestock exhibitors became infected with *E. coli* O157:H7 in at least one fair outbreak (20).

ADDITIONAL HEALTH CONCERNS

Although enteric diseases are the most commonly reported health risks associated with animals in public settings, other health risks are of concern. For example, allergies can be associated with animal dander, scales, fur, feathers, body wastes (urine), and saliva (67-69). Additional health concerns addressed in this report include injuries, rabies exposures, and other infections.

Injuries

Injuries associated with animals in public settings include bites, kicks, falls, scratches, stings, crushing of the hands or feet, and being pinned between the animal and a fixed object. These injuries have been associated with big cats (e.g., tigers), monkeys, and other domestic and zoo animals. The settings have included public stables, petting zoos, traveling photo opportunities, schools, children's parties, and animal rides (M. Eidson, New York State Dept. of Health; J. Bender, University of Minnesota; M. Jay-Russell, California Department of Health; G. Swinger, Tennessee Dept. of Health, 2003). For example, a Kansas teenager was killed while posing for her senior year photo with a tiger being restrained by its handler at an animal sanctuary (www.sshep.com/stun_gun.htm).

Rabies Exposures

Contact with rabid mammals can expose persons to rabies virus through bites or contamination of mucous membranes, scratches, or other wounds with infected saliva or nervous tissue. Although no human rabies deaths caused by animal contact in public exhibits have been recorded, multiple rabies exposures have occurred, requiring extensive public health investigation and medical follow-up. For example, in the previous decade, thousands of persons have received rabies postexposure prophylaxis (PEP) after being exposed to rabid or potentially rabid animals (including cats, goats, bears, sheep, ponies, and dogs) at a variety of venues: a pet store in New Hampshire (70); a county fair in New York State (71); petting zoos in Iowa (72, 73) and Texas (personal communication, J. Wright, Texas Department of Health, 2004); and school and rodeo events in Wyoming (1). Substantial public health and medical care challenges associated with potential mass rabies exposures include difficulty in identifying and contacting persons, correctly assessing exposure risks, and providing timely medical treatment. Prompt assessment and treatment are critical to prevent this disease, which is usually fatal.

Other Infections

Multiple bacterial, viral, fungal, and parasitic agents have been associated with

animal contact. These organisms are transmitted through various modes. Infections from animal bites are common and frequently require extensive treatment or hospitalization. Bacterial pathogens associated with animal bites include *Pasteurella*, *Francisella* (74), *Staphylococcus*, *Streptococcus*, *Capnocytophaga canimorsus*, *Bartonella henselae* (cat-scratch disease), and *Streptobacillus moniliformis* (rat-bite fever). Certain monkey species (especially macaques) kept as pets or used in public exhibitions can be infected with herpes B virus, either asymptomatically or with mild oral lesions. Human exposure through monkey bites or bodily fluids can result in a fatal meningoencephalitis (75, 76). Because of difficulties with laboratory testing to confirm monkey infection and high herpes B prevalence, monkey bites can require considerable public health and medical follow-up.

Skin contact with animals in public settings can also result in human infection. Fifteen cases of ringworm infection (club lamb fungus) caused by *Trichophyton* species and *Microsporum gypseum* were documented among owners and family members who exhibited lambs in Georgia during a show season (77). Ringworm infection in 23 persons and multiple animal species were traced to a *Microsporum canis* infection in a hand-reared zoo tiger cub (78). Orf virus infections (contagious ecthyma or sore mouth) occurred in goats and sheep at a children's petting zoo (79) and in a lamb used for an Easter photo opportunity (M. Eidson, New York State Department of Health, 2003), although human cases were not confirmed in these incidents. After handling various species of infected exotic animals, a zoo attendant experienced an extensive papular skin rash from a cowpox-like virus (80). In 2003, multiple cases of monkeypox occurred among persons who had contact with infected prairie dogs either at a child care center (81, 82) or a pet store (J.J. Kazmierczak, Wisconsin Department of Health and Family Services, 2004).

Ecto- and endoparasites pose concerns when humans and exhibit animals interact. *Sarcoptes scabiei* is a skin mite that infests humans and animals, including swine, dogs, cats, foxes, cattle, and coyotes (83, 84). Although human infestation from animal sources is usually self-limiting, skin irritation and itching may occur for multiple days and be difficult to diagnose (83-85). Animal flea bites to humans increase the risk for infection or allergic reaction. In addition, fleas are the intermediate host for a tapeworm species that can infect children. Animal helminthes (i.e., intestinal worms) can infect humans through fecal-oral contact or through contact with animals or contaminated earth (86, 87). Parasite-control through veterinary care and proper husbandry, coupled with hand-washing, reduces the risks associated with ecto- and endoparasites (88).

Tuberculosis (TB) is another disease of concern in certain animal settings. Twelve circus elephant handlers at an exotic animal farm in Illinois were infected with *Mycobacterium tuberculosis,* and one handler had signs consistent with active disease after three elephants died of TB. Medical history and testing of the handlers indicated that the elephants had been a probable source of exposure for the majority of the human infections (89). At a zoo in Louisiana, seven animal handlers who were previously negative for TB tested positive after a *Mycobacterium bovis* outbreak in rhinoceroses and monkeys (90). The U.S. Department of Agriculture (USDA) developed guidelines regarding removal of TB-infected animals from public contact as a result of concerns regarding the risk for exposure to the public (91).

Zoonotic pathogens can also be transmitted by direct or indirect contact with

reproductive fluids, aborted fetuses, or newborns from infected dams. Live-birthing exhibits, usually involving livestock (e.g., cattle, pigs, goats, or sheep), are popular at agricultural fairs. Although the public usually does not have direct contact with animals during birthing, newborns and their dams are frequently available for petting and observation afterward. Q fever (*Coxiella burnetii*), leptospirosis, listeriosis, brucellosis, and chlamydiosis are serious zoonoses that can be acquired via contact with reproductive materials (92).

C. burnetii is a rickettsial organism that most frequently infects cattle, sheep, and goats. The disease can cause abortion in animals, but more frequently the infection is asymptomatic. During parturition, infected animals shed substantial numbers of organisms that might become aerosolized. The majority of persons exposed to *C. burnetii* develop an asymptomatic infection, but clinical illness can range from an acute influenza-like illness to life-threatening endocarditis. A Q fever outbreak involving 95 confirmed case-patients and 41 hospitalizations was linked to goats and sheep giving birth at petting zoos. These petting zoos were in indoor shopping malls, indicating that indoor-birthing exhibits might pose an increased risk for Q fever transmission (93).

Chlamydophila psittaci infections cause respiratory disease (commonly called psittacosis) and are usually acquired from psittacine birds (94). For example, an outbreak of *C. psittaci* pneumonia occurred among the staff at the Copenhagen Denmark Zoo (95). On rare occasions, chlamydial infections acquired from sheep, goats, and birds result in reproductive problems in humans (94, 96, 97).

RECOMMENDATIONS

Guidelines and recommendations from multiple organizations contributed to the recommendations in this report. In the United Kingdom and Canada, recommendations to prevent enteric infections at animal exhibitions and agricultural fairs were developed in 1989 (101), 1995 (102), and 2000 (103). No federal laws in the U.S. address the risk for transmission of pathogens at venues where the public has contact with animals. A limited number of states have specific legislation for venues where animals are present in public settings (1, 16, 98-100). In 2005, after their state fair outbreak, North Carolina passed a law requiring agricultural fairs to obtain a permit from the Department of Agriculture for all animal exhibitions opened to the public (http://www.ncleg.net/sessions/2005/bills/senate/pdf/s268b4.pdf).

Some federal agencies and associations in the United States have developed standards, recommendations, and guidelines for venues where animals are present in public settings. The American Zoo and Aquarium Association has accreditation standards for reducing risks of animal contact with the public in zoological parks (104). In accordance with the Animal Welfare Act, USDA Animal Care licenses and inspects certain animal exhibits for humane treatment of animals, but this act is not intended for human health protection. In 2001, CDC issued guidelines to reduce the risk of infection with enteric pathogens from farm visits (16). CDC has also issued recommendations for preventing transmission of *Salmonella* from reptiles to humans (105). The Association for Professionals in Infection Control and Epidemiology (APIC) developed guidelines to address risks associated with the use of service animals in health-care settings (2).

Opportunities for animal contact with the public occur in various settings. Recommendations provided in this report should be tailored to specific settings, and the report should be incorporated into guidelines and regulations developed at the state or local level. More detailed recommendations are provided in Appendix A, Hand-Washing Recommendations to Reduce Disease Transmission from Animals in Public Settings; Appendix B, Animals in Public Settings—Information for Visitors; Appendix C, Two Possible Designs for Animal Contact Facilities; Appendix D, Guidelines for Visiting and Resident Animals in Schools; and Appendix E, Disinfectants and Properties.

Recommendations for Local, State, and Federal Agencies

Communication and cooperation between human and animal health agencies should be enhanced, and include cooperative extension offices. Additional research should be conducted at all levels, including academia, into the risk factors and effective prevention and control methods for these health issues.

To improve use of these recommendations, agencies should:

- Disseminate this report to venue operators. Most states do not have a complete list of animal contact venues (1). States should strive to develop a complete list to facilitate dissemination of recommendations.
- Develop and disseminate educational and training materials to venue operators and other interested persons. Material formats could include PowerPoint slide presentations, videos, and written guidelines (98, 99, 106).
- Encourage or require oversight to ensure compliance with recommendations at animal contact venues.

To evaluate and improve these recommendations, surveillance of health issues associated with animal contact should be enhanced. Agencies should:

- Conduct thorough epidemiological investigations of outbreaks.
- Include questions about exposure to animals and their environment on disease report forms and outbreak investigation questionnaires.
- Follow appropriate protocols for sampling of humans, animals, and the environment, and for testing and subtyping of isolates.
- Report outbreaks to state health departments and CDC.

Recommendations for Education

Education is essential to reduce risks associated with animal contact in public settings. Experience from outbreaks suggests that visitors knowledgeable about potential risks are less likely to become ill (18).

Venue operators should:

- Be familiar with and implement the risk-reduction recommendations contained in this report.
- Consult with state and local agencies and county extension agents on implementation of the recommendations.
- Develop or obtain training and education materials, and assure that staff are appropriately trained.
- Assure that visitors and exhibitors receive educational messages, for example, with handouts such as that in Appendix B.
- Provide information to persons arranging school field trips or classroom exhibits.

Venue staff should:

- Be trained to reduce the risk for disease and injury associated with animals, and be able to explain risk reduction recommendations to visitors.
- Encourage compliance by the public with risk-reduction recommendations, especially compliance with hand-washing procedures (Appendix A) as the visitors exit animal areas.
- Comply with local and state requirements for reporting animal bites, scratches, or other injuries.
- Assure that visitors receive educational messages.

To educate visitors, venue operators and staff should:

- Provide information about disease risks and appropriate measures to reduce risk. Inform visitors which groups of people are at high risk of serious infection and the precautions visitors should take (see Additional Recommendations and Appendix B).
- Provide information before the event, and at the animal contact area entrances and exits.
- Provide information in a simple and easy to understand format that is age- and language-appropriate.
- Provide information in multiple formats (e.g., signs, stickers, handouts [Appendix B], and verbal information).

Recommendations for Managing Public and Animal Contact

The recommendations in this compendium were developed for settings in which direct animal contact is encouraged (e.g., petting zoos) as well as settings in which animal contact is possible (e.g., county fairs). The public's contact with animals should occur in settings where measures are in place to reduce the potential for injuries or disease transmission and to increase the probability that incidents or problems identified with animal contact settings will be reported, documented, and handled appropriately. The design of facilities and animal pens (Appendix C) should minimize the risk for these contacts, particularly with manure, and facilitate hand-washing (Appendix A). Double barriers can be used to prevent contact with animals or contaminated surfaces. Temporary exhibits should be carefully planned, designed, and managed to avoid problems identified from previous outbreaks. Common problems include inadequate barriers, floor surfaces that are difficult to keep clean, and insufficient plumbing, and inadequate hand-washing facilities (12, 18, 33, 34).

The following recommendations address nonanimal areas (areas in which animals are not permitted, with the exception of service animals), transition areas (both for entrances and exits), and animal areas (where animal contact is possible or encouraged) (Appendix C). Specific guidelines might be necessary for certain settings (e.g., schools [Appendix D]). Recommendations for cleaning procedures should be tailored to the specific situation (Appendix E).

Nonanimal Areas

Nonanimal areas are areas in which animals are not permitted.

- Do not permit animals, except service animals, in nonanimal areas.
- Prepare, serve, and consume food and beverages only in nonanimal areas.
- Provide hand-washing facilities and display hand-washing signs where food or

beverages are served (Appendix A).

Transition Areas Between Nonanimal and Animal Areas

Establishing transition areas for visitors to pass through when entering and exiting animal areas is critical. One way visitor flow is preferred with separate entrance and exit points. The transition areas should be designated as clearly as possible, even if they need to be conceptual rather than physical (Appendix C).

Entrance transition areas should be designed to facilitate education.

- Post signs informing visitors that they are entering an animal area. These signs should also instruct visitors not to eat, drink, smoke, place their hands in their mouth, or use bottles or pacifiers while in the animal area.
- Exclude strollers, food, and beverages. Establish storage or holding areas for these items.
- Control visitor traffic at the entrance transition area to avoid overcrowding.

Exit transition areas should be designed to facilitate hand-washing.

- Post signs instructing visitors to wash their hands.
- Provide accessible hand-washing stations for all visitors, including children and persons with disabilities (Appendix C).
- Position venue staff near exits to encourage compliance with hand-washing.

Animal Areas

In buildings where animals are housed, adequate ventilation is essential for both animals (107) and humans. Additional recommendations for animal areas include:

- Exclude food and beverages. Animal feed and water should not be accessible to the public.
- Exclude toys, pacifiers, spill-proof cups ("sippy cups"), baby bottles, and smoking.
- Remove manure and soiled animal bedding promptly.
- Store animal waste and specific tools for waste removal (e.g., shovels and pitchforks) in designated areas restricted from public access.
- Avoid transporting manure and soiled bedding through nonanimal areas or transition areas. If this is unavoidable, take precautions to avoid spillage and aerosolization.
- Where feasible, disinfect animal areas (e.g., flooring, railings) at least once daily.
- Supervise children closely to discourage hand to mouth activities (e.g., thumb-sucking), contact with manure, and contact with soiled bedding. If hands become soiled, supervise hand-washing.
- Assign trained staff to encourage appropriate human-animal interactions, to identify and remove potential risks for patrons (e.g., by promptly cleaning up wastes), and to process reports of injuries and exposures.
- Use barriers between public and animals in petting zoo areas to reduce excessive contact and contamination of clothing.
- Allow feeding only when contact with animals is controlled, for example with barriers.
- Do not provide animal feed in containers that can be eaten by persons (e.g., ice cream cones), to reduce animal bites and prevent children eating food that has come into contact with animals.

- Use animals or animal products (e.g., animal pelts, animal waste, and owl pellets) (108) for educational purposes only in designated animal areas (Appendix C). Animals and animal products should not be brought into school cafeterias and other food-consumption areas.
- Do not use animal areas for public (nonanimal) activities. Zoonotic pathogens can contaminate the environment for substantial periods of time (36). If animal areas must be used for public events (e.g., weddings and dances), these areas should be cleaned and disinfected, particularly if food and beverages are served. Materials with smooth, impervious surfaces (e.g., steel, plastic, and sealed concrete) are easier to clean than other materials (e.g., wood or dirt floors). Removing organic material (bedding, feed, and manure) before using disinfectants is important. A list of disinfectants is included in this report (Appendix E).
- For animals in school classrooms, specific areas must be designated for animal contact. Designated animal areas must be thoroughly cleaned after use (Appendix E).

Animal Care and Management

The risk for disease or injuries from animal contacts can be reduced by carefully managing the specific animals used for such contacts. These recommendations should be considered for management of animals in contact with the public.

- **Animal care:** Monitor animals daily for signs of illness and ensure that animals receive appropriate veterinary care. Ill animals, animals known to be infected with a pathogen, and animals from herds with a recent history of abortion or diarrhea should not be exhibited. Animals should be housed to minimize stress and overcrowding, which can increase shedding of microorganisms.
- **Veterinary care:** Retain and use the services of a licensed veterinarian. Vaccination, preventive care, and parasite control appropriate for the species should be provided. Health certificates from a licensed veterinarian should be up-to-date according to local or state requirements for animals in public settings. A herd or flock inspection is a critical component of the health certificate process. Screening for diseases is not recommended except for tuberculosis in elephants (89-91) and primates, and for Q fever in ruminants in birthing exhibits (109-110).
- **Rabies:** House exhibit-animals to reduce potential exposures from wild animals. Mammals should also be up-to-date on their rabies vaccinations (111). These steps are particularly critical in areas where rabies is endemic and in venues where animal contact is encouraged (e.g., petting zoos). Because of the extended incubation period for rabies, unvaccinated mammals should be vaccinated at least 3 months before they have contact with the public. If no licensed rabies vaccine exists for a particular species used in a setting where public contact occurs (e.g., goats, llamas, and camels), consultation with a veterinarian is recommended regarding the use of off-label rabies vaccine. Off-label vaccines cannot provide the same level of assurance as vaccines labeled for use in particular species, but the off-label use of vaccine may provide protection for some animals and thus decrease the probability of rabies transmission. Vaccinating slaughter-class animals before displaying them at fairs might not be feasible because of the vaccine withdrawal period that occurs as a result of antibiotics used as

preservatives in certain vaccines. Mammals that are too young to be vaccinated should be used only if additional restrictive measures are available to reduce and manage risks. These measures can include using only animals that were born to vaccinated mothers and housed to avoid rabies exposure. Records or logs of visitors should be maintained to facilitate locating persons or groups in situations where tracing contacts might be required (e.g., potential rabies exposures).

- **Dangerous animals:** Prohibit certain domestic, exotic, or wild animals in exhibit settings where a possibility of animal contact exists, because of their strength, unpredictability, venom, or the pathogens that they might carry. Species of primary concern include nonhuman primates (e.g., monkeys and apes) and certain carnivores (e.g., lions, tigers, ocelots, wolves/wolf-hybrids, and bears). In addition, rabies-reservoir species (e.g., bats, raccoons, skunks, foxes, and coyotes) should not be used.
- **Animal births:** Ensure that the public has no contact with animal birthing by-products. In live-birth exhibits, the environment should be thoroughly cleaned after each birth, and all waste products should be properly discarded. Holding such events outside is preferable, because if they are held inside, there is risk of organisms being spread through ventilation systems.

Additional Recommendations

- **Populations at high risk:** Children aged < 5 years are at particularly high risk of serious infections. Other groups at increased risk include persons with waning immunity (e.g., older adults) and persons who are cognitively impaired, pregnant, or immunocompromised (e.g., persons with human immunodeficiency virus/acquired immunodeficiency syndrome, without a functioning spleen, or on immunosuppressive therapy). Persons at high risk should take heightened precautions at any animal exhibit. In addition to thorough and frequent hand-washing, heightened precautions might include avoiding contact with animals and their environment (e.g., pens, bedding, and manure). Animals of particular concern for transmitting enteric diseases include young ruminants, young poultry, reptiles, amphibians, and ill animals. For young children, risk for exposure might be reduced if they are closely supervised by adults, carried by adults in animal areas, or have animal contact only over a barrier. These measures discourage animals from jumping on or nuzzling children and minimize contact with feces and soiled bedding.
- **Consumption of unpasteurized products:** Prohibit the consumption of unpasteurized dairy products (e.g., milk, cheese, and yogurt) as well as unpasteurized apple cider or juices.
- **Drinking water:** Local public health authorities should inspect drinking water systems before use. Only potable water should be used for human consumption. Back-flow prevention devices should be installed between outlets in livestock areas and water lines supplying other uses on the grounds. If the water supply is from a well, adequate distance should be maintained from possible sources of contamination (e.g., 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 "water not for human consumption." Operators and managers of these settings in which treated municipal water is not available should consider alternative methods for disinfection of their water supply (or should consider methods to disinfect their water supply.)

References

1. Bender JB, Shulman SA. Reports of zoonotic disease outbreaks associated with animal exhibits and availability of recommendations for preventing zoonotic disease transmission from animals to people in such settings. J Am Vet Med Assoc 2004;224:1105–9.
2. Duncan SL. APIC state-of-the-art report: the implications of service animals in health care settings. Am J Infect Control 2000;28:170–80.
3. Sehulster L, Chinn R, Arduino M, et al. Guidelines for environmental infection control in health-care facilities: recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC). Chicago, IL: American Society for Healthcare Engineering/American Hospital Association; 2004. Available at http://www.cdc.gov/ncidod/hip/enviro/Enviro_guide_03.pdf.
4. Guay DRP. Pet-assisted therapy in the nursing home setting: potential for zoonosis. Am J Infect Control 2001;29:178–86.
5. LeJeune JT, Davis MA. Outbreaks of zoonotic enteric disease associated with animal exhibits. J Am Vet Med Assoc 2004;224:1440–5.
6. Chappell CL, Okhuysen PC, Sterling CR, DuPont HL. *Cryptosporidium parvum*: intensity of infection and oocyst excretion patterns in healthy volunteers. J Infect Dis 1996;173:232–6.
7. Bell BP, Goldoft M, Griffin PM, et al. A multistate outbreak of *Escherichia coli* O157:H7-associated bloody diarrhea and hemolytic uremic syndrome from hamburgers: the Washington experience. JAMA 1994;272:1349–53.
8. Tilden J Jr, Young W, McNamara A-M, et al. A new route of transmission for *Escherichia coli*: infection from dry fermented salami. Am J Public Health 1996;86:1142–5.
9. Shukla R, Slack R, George A, Cheasty T, Rowe B, Seutter J. *Escherichia coli* O157 infection associated with a farm visitor centre. Commun Dis Rep CDR Rev 1995;5:R86–90.
10. Sayers GM, Dillon MC, Connolly E, et al. Cryptosporidiosis in children who visited an open farm. Commun Dis Rep CDR Rev 1996;6:R140–4.
11. Evans MR, Gardner D. Cryptosporidiosis outbreak associated with an educational farm holiday. Commun Dis Rep CDR Rev 1996;6:R50–1.
12. Friedman CR, Torigian C, Shillam PJ, et al. An outbreak of salmonellosis among children attending a reptile exhibit at a zoo. J Pediatr 1998;132:802–7.
13. Pritchard GC, Willshaw GA, Bailey JR, Carson T, Cheasty T. Verocytotoxin-producing *Escherichia coli* O157 on a farm open to the public: outbreak investigation and longitudinal bacteriological study. Vet Rec 2000;147:259–64.
14. Crump JA, Sulka AC, Langer AJ, et al. An outbreak of *Escherichia coli* O157:H7 infections among visitors to a dairy farm. N Engl J Med 2002;347:555–60.
15. Warshawsky B, Gutmanis I, Henry B, et al. An outbreak of *Escherichia coli* O157:H7 related to animal contact at a petting zoo. Can J Infect Dis 2002;13:175–81.
16. CDC. Outbreaks of *Escherichia coli* O157:H7 infections among children associated with farm visits—Pennsylvania and Washington, 2000. MMWR 2001;50:293–7.
17. Chapman PA, Cornell J, Green C. Infection with verocytotoxin-producing *Escherichia coli* O157 during a visit to an inner city open farm. Epidemiol Infect 2000;125:531–6.
18. CDC. Outbreaks of *Escherichia coli* O157:H7 associated with petting zoos --- North Carolina, Florida, and Arizona, 2004 and 2005. MMWR 2005;54: 1277-1280.
19. David ST, MacDougall L, Louie K, McIntyre L, Paccagnella AM, Schleicher S, Hamade A. Petting zoo-associated *Escherichia coli* O157:H7—secondary transmission, asymptomatic infection, and prolonged shedding in the classroom. CCDR-RMTC Canada Communicable Disease Report 2004;30:I73-I80.

20. Durso LM, Reynolds K, Bauer N, Keen JE. Shiga-toxigenic *Escherichia coli* O157:H7 infections among livestock exhibitors and visitors at a Texas county fair. Vector-Borne and Zoonotic Diseases 2005; 5: 193-201.
21. Kiang KM, Scheftel JM, Leano FT, Taylor CM, Belle-Isle PA, Cebelinski, EA, Danila R, Smith KE. Recurrent outbreaks of cryptosporidiosis associated with calves among students at an educational farm programme, Minnesota, 2003. Epidemiol Infect 2005; 1-9.
22. Keene WE, deBroekert M, Gillette K. A large *Escherichia coli* O157:H7 outbreak at a county fair [Abstract 55:77]. In: Programs and abstracts of the International Conference on Emerging Infectious Diseases; February 29–March 3, 2004; Atlanta, GA; 2004.
23. CDC. *Salmonella hadar* associated with pet ducklings—Connecticut, Maryland, and Pennsylvania, 1991. MMWR 1992;41:185–7.
24. CDC. *Salmonella* serotype Montevideo infections associated with chicks—Idaho, Washington, and Oregon, spring 1995 and 1996. MMWR 1997;46:237–9.
25. CDC. Salmonellosis associated with chicks and ducklings—Michigan and Missouri, Spring 1999. MMWR 2000;49:297–9.
26. CDC. Outbreak of multidrug-resistant *Salmonella* Typhimurium associated with rodents purchased at retail pet stores – United States, December 2003—October 2004. MMWR 2005; 54: 429-433.
27. Keen JE, Elder RO. Isolation of shiga-toxigenic *Escherichia coli* O157 from hide surfaces and the oral cavity of finished beef feedlot cattle. J Am Vet Med Assoc 2002;220:756–63.
28. Sharp JCM. Infections associated with milk and dairy products in Europe and North America, 1980–85. Bull World Health Organ 1987;65:397–406.
29. Djuretic T, Wall PG, Nichols G. General outbreaks of infectious intestinal disease associated with milk and dairy products in England and Wales: 1992 to 1996. Commun Dis Rep CDR Rev 1997;7:R41–5.
30. Korlath JA, Osterholm MT, Judy LA, Forfang JC, Robinson RA. A point-source outbreak of campylobacteriosis associated with consumption of raw milk. J Infect Dis 1985;152:592–6.
31. Payne CJI, Petrovic M, Roberts RJ, et al. Vero cytotoxin-producing *Escherichia coli* O157 gastroenteritis in farm visitors, North Wales. Emerg Infect Dis 2003;9:526–30.
32. Anonymous. Waterborne outbreak of gastroenteritis associated with a contaminated municipal water supply, Walkerton, Ontario, May–June 2000. Can Commun Dis Rep 2000;26:170–3.
33. Bopp DJ, Sauders BD, Waring AL, et al. Detection, isolation, and molecular subtyping of *Escherichia coli* O157:H7 and *Campylobacter jejuni* associated with a large waterborne outbreak. J Clin Microbiol 2003;41:174–80.
34. CDC. Outbreak of *Escherichia coli* O157:H7 and *Campylobacter* among attendees of the Washington County Fair—New York, 1999. MMWR 1999;48:803–5.
35. Croft DR, Archer J, Roberts C. Johnson, et al. Outbreak of *Escherichia coli* O157:H7 infections associated with a pancake breakfast served in a stock pavilion with contaminated livestock bedding—Wisconsin, 2001. In: Programs and abstracts of the 51st Annual Epidemic Intelligence Conference (EIS); April 22–26, 2002; Atlanta, GA; 2002:74–7.
36. Varma JK, Greene KD, Reller ME, et al. An outbreak of *Escherichia coli* O157 infection following exposure to a contaminated building. JAMA 2003;290:2709–12.
37. Doorduyn Y, Van Den Brandhof WE, Van Duynhoven YTHP, Wannet WJB, Van Pelt W. Risk Factors for *Salmonella* Enteritidis and Typhimurium (DT104 and non-DT104) infections in the Netherlands: predominant roles for raw eggs in Enteritidis and sandboxes in Typhimurium infections. Epidemiol Infect 2005; 000: 1-10.
38. Kudva IT, Blanch K, Hovde CJ. Analysis of *Escherichia coli* O157:H7 survival in ovine or bovine manure and manure slurry. Appl Environ Microbiol 1998;64:3166–74.
39. LeJeune JT, Besser TE, Hancock DD. Cattle water troughs as reservoirs of *Escherichia coli* O157. Appl Environ Microbiol 2001;67:3053–7.
40. Maule A. Survival of verocytotoxigenic *Escherichia coli* O157 in soil, water and on surfaces. J Appl Microbiol 2000;(Suppl 88):S71–8.
41. Randall LP, Wray C, Davies RH. Survival of verocytotoxin-producing *Escherichia coli* O157 under simulated farm conditions. Vet Rec 1999;145:500–1.
42. Rahn K, Renwick SA, Johnson RP, et al. Persistence of *Escherichia coli* O157:H7 in dairy cattle and the dairy farm environment. Epidemiol Infect 1997;119:251–9.
43. Williams LP Jr, Newell KW. *Salmonella* excretion in joy-riding pigs. Am J Public Health Nations Health 1970;60:926–9.

44. Hurd HS, McKean JD, Wesley IV, Karriker LA. The effect of lairage on *Salmonella* isolation from market swine. J Food Prot 2001;64:939–44.
45. Isaacson RE, Firkins LD, Weigel RM, Zuckermann FA, DiPietro JA. Effect of transportation and feed withdrawal on shedding of *Salmonella typhimurium* among experimentally infected pigs. Am J Vet Res 1999;60:1155–8.
46. Hurd HS, McKean JD, Griffith RW, Wesley IV, Rostagno MH. *Salmonella* enterica infections in market swine with and without transport and holding. Appl Environ Microbiol 2002;68:2376–81.
47. Marg H, Scholz HC, Arnold T, Rosler U, Hensel A. Influence of long-time transportation stress on re-activation of *Salmonella typhimurium* DT104 in experimentally infected pigs. Berl Munch Tierarztl Wochenschr 2001;114:385–8.
48. Corrier DE, Purdy CW, DeLoach JR. Effects of marketing stress on fecal excretion of *Salmonella* spp in feeder calves. Am J Vet Res 1990;51:866–9.
49. US Department of Agriculture. *Escherichia coli* O157 in the United States feedlots. Fort Collins, CO: US Department of Agriculture, Centers for Epidemiology and Animal Health, Animal and Plant Health Inspection Service, Veterinary Services; 2001. Available at http://www.aphis.usda.gov/vs/ceah/ncahs/nahms/feedlot/Feedlot99/FD99ecoli.pdf.
50. Webb CR. Investigating the potential spread of infectious diseases of sheep via agricultural shows in Great Britain. Epidemiol Infect 2006; 134 (1): 31-40.
51. Castro-Hermida JA, Gonzalez-Losada YA, Ares-Mazas E. Prevalence of and risk factors involved in the spread of neonatal bovine cryptosporidiosis in Galicia (NW Spain). Vet Parasitol 2002;106:1–10.
52. Garber LP, Wells SJ, Hancock DD, et al. Risk factors for fecal shedding of *Escherichia coli* O157:H7 in dairy calves. J Am Vet Med Assoc 1995;207:46–9.
53. Hancock DD, Besser TE, Kinsel ML, Tarr PI, Rice DH, Paros MG. The prevalence of *Escherichia coli* O157.H7 in dairy and beef cattle in Washington State. Epidemiol Infect 1994;113:199–207.
54. Hancock DD, Besser TE, Rice DH, Herriott DE, Tarr PI. A longitudinal study of *Escherichia coli* O157 in fourteen cattle herds. Epidemiol Infect 1997;118:193–5.
55. US Department of Agriculture. *Salmonella* in United States feedlots. Fort Collins, CO: US Department of Agriculture, Centers for Epidemiology and Animal Health, Animal and Plant Health Inspection Service, Veterinary Services; 2001. Available at http://www.aphis.usda.gov/vs/ceah/ncahs/nahms/feedlot/Feedlot99/FD99salmonella.pdf.
56. Crump JA, Braden CR, Dey ME, et al. Outbreaks of *Escherichia coli* O157 infections at multiple county agricultural fairs: a hazard of mixing cattle, concession stands and children. Epidemiol Infect 2003;131:1055–62.
57. Smith KE, Stenzel SA, Bender JB, et al. Outbreaks of enteric infections caused by multiple pathogens associated with calves at a farm day camp. Ped Infect Dis J 2004;23:1098–104.
58. North Carolina Department of Health and Human Services. *E. coli* outbreak. Raleigh, NC: North Carolina Department of Health and Human Services; 2004. Available at http://www.dhhs.state.nc.us/docs/ecoli.htm.
59. Kassenborg HD, Hedberg CW, Hoekstra M, et al. Farm visits and undercooked hamburgers as major risk factors for sporadic *Escherichia coli* O157:H7 infection: data from a case-control study in 5 FoodNet sites. Clin Infect Dis 2004;38(Suppl 3):S271–8.
60. O'Brien SJ, Adak GK, Gilham C. Contact with farming environment as a major risk factor for Shiga toxin (Vero cytotoxin)-producing *Escherichia coli* O157 infection in humans. Emerg Infect Dis 2001;7:1049–51.
61. Haack JP, Jelacic S, Besser TE, et al. *Escherichia coli* O157 exposure in Wyoming and Seattle: serologic evidence of rural risk. Emerg Infect Dis 2003;9:1226–31.
62. Soderlund D, Smith K, Bender J, Hedberg C. An epidemiologic investigation of cryptosporidiosis in Minnesota. In: Programs and abstracts of the International Conference on Emerging Infectious Diseases; July 16–19, 2000, Atlanta, GA; 2000:148.
63. Roy SL, DeLong SM, Stenzel SA, et al. Risk factors for sporadic cryptosporidiosis among immunocompetent persons in the United States from 1999 to 2001. J Clin Microbiol 2004;42:2944–51.
64. Hunter PR, Hughes S, Woodhouse S, et al. Sporadic cryptosporidiosis case-control study with genotyping. Emerg Infect Dis 2004;10:1241–9.
65. Friedman CR, Hoekstra RM, Samuel M, et al. Risk factors for sporadic *Campylobacter* infection in the United States: a case-control study in FoodNet sites. Clin Infect Dis 2004;38(Suppl 3):S285–96.
66. Belongia EA, Chyou P-H, Greenlee RT, Perez-Perez G, Bibb WF, DeVries EO. Diarrhea incidence

and farm-related risk factors for *Escherichia coli* O157:H7 and *Campylobacter jejuni* antibodies among rural children. J Infect Dis 2003;187:1460–8.
67. American Academy of Allergy Asthma and Immunology. Executive summary report, 1998. Milwaukee, WI: Task Force on Allergic Disorders, 1998.
68. Bardana EJ Jr. What characterizes allergic asthma? Ann Allergy 1992;68:371–3.
69. Lincoln TA, Bolton NE, Garrett AS Jr. Occupational allergy to animal dander and sera. J Occup Med 1974;16:465–9.
70. CDC. Mass treatment of humans exposed to rabies—New Hampshire, 1994. MMWR 1995;44:484–6.
71. Chang H-GH, Eidson M, Noonan-Toly C, et al. Public health impact of reemergence of rabies, New York. Emerg Infect Dis 2002;8:909–13.
72. CDC. Public health response to a potentially rabid bear cub—Iowa, 1999. MMWR 1999;48:971–3.
73. CDC. Multiple human exposures to a rabid bear cub at a petting zoo and barnwarming—Iowa, August 1999. MMWR 1999;48:761.
74. CDC. Brief Report: Tularemia associated with a hamster bite --- Colorado, 2004. MMWR 2005; 53: 1202-1203.
75. CDC. Fatal Cercopithecine herpesvirus 1 (B virus) infection following a mucocutaneous exposure and interim recommendations for worker protection. MMWR 1998;47:1073–6, 1083.
76. Cohen JI, Davenport DS, Stewart JA, et al. Recommendations for prevention of and therapy for exposure to B virus (Cercopithecine herpesvirus 1). Clin Infect Dis 2002;35:1191–203.
77. Hullinger GA, Cole JR Jr, Elvinger F, Stewart RL. Dermatophytosis in show lambs in the United States. Veterinary Dermatol 1999;10:73–6.
78. Scott WA. Ringworm outbreak [Letter]. Vet Rec 1986;118:342.
79. Stover J, Dolensek EP, Basford S, Beheny J. Contagious ecthyma in a children's Zoo. J Zoo An Med 1986;17:115–6.
80. Marennikova SS, Maltseva NN, Korneeva VI, Garanina NM. Outbreak of pox disease among carnivora (felidae) and edentata. J Infect Dis 1977;135:358–66.
81. Kile JC, Fleishchauer AT, Kuehnert MJ, et al. Transmission of monkeypox among exposed daycare attendees: Indiana, 2003 [Abstract 51:132]. In: Programs and abstracts of the International Conference on Emerging Infectious Diseases; February 29–March 3; Atlanta, GA; 2004.
82. CDC. Update: Multistate outbreak of monkeypox—Illinois, Indiana, Kansas, Missouri, Ohio, and Wisconsin, 2003. MMWR 2003;52:642–6.
83. Angarano DW, Parish LC. Comparative dermatology: parasitic disorders. Clin Dermatol 1994;12:543–50.
84. Arlian LG. Biology, host relations, and epidemiology of *Sarcoptes scabiei*. Annu Rev Entomol 1989;34:139–61.
85. Scott DW, Horn RT Jr. Zoonotic dermatoses of dogs and cats. Vet Clin North Am Small Anim Pract 1987;17:117–44.
86. Molina CP, Ogburn J, Adegboyega P. Infection by *Dipylidium caninum* in an infant. Arch Pathol Lab Med 2003;127:e157–9.
87. Currier RW 2nd, Kinzer GM, DeShields E. *Dipylidium caninum* infection in a 14-month-old child. South Med J 1973;66:1060–2.
88. Schantz PM. Toxocara larva migrans now. Am J Trop Med Hyg 1989;41(Suppl 3):21–34.
89. Michalak K, Austin C, Diesel S, Bacon JM, Zimmerman P, Maslow JN. *Mycobacterium tuberculosis* infection as a zoonotic disease: transmission between humans and elephants. Emerg Infect Dis 1998;4:283–7.
90. Stetter MD, Mikota SK, Gutter AF, et al. Epizootic of *Mycobacterium bovis* in a zoologic park. J Am Vet Med Assoc 1995;207:1618–21.
91. US National Tuberculosis Working Group for Zoo and Wildlife Species. Guidelines for the control of tuberculosis in elephants, 2003. Riverdale, MD: US National Tuberculosis Working Group for Zoo and Wildlife Species; 2003. Available at http://www.aphis.usda.gov/ac/TBGuidelines2003.pdf.
92. Heymann DL, ed. Control of communicable diseases manual. 18th edition. Washington, DC: American Public Health Association; 2004.
93. Milford F, Vibien A, Lambert L, Morin M, Petit G, Trottier J. Large Q-fever outbreak related to exposure to petting zoos in two shopping malls. Programs and abstracts of the 51st Annual Conference on Diseases in Nature Transmissible to Man; June 2001; Austin. TX, 2001.
94. Smith KA, Bradley KK, Stobierski MG, Tengelsen LA. Compendium of measures to control

Chlamydophila psittaci (formerly Chlamydia psittaci) infection among humans (psittacosis) and pet birds, 2005. J Am Vet Med Assoc 2005;226:532–9.
95. Christensen AL, Jarlov JO, Ingeberg S. The risk of ornithosis among the staff of Copenhagen Zoo [Danish]. Ugeskr Laeger 1990;152:818–20.
96. Hyde SR, Benirschke K. Gestational psittacosis: case report and literature review. Mod Pathol 1997;10:602–7.
97. Eidson M. Psittacosis/avian chlamydiosis. J Am Vet Med Assoc 2002;221:1710–12.
98. Washington State Department of Health. Recommendations to reduce the risk of disease transmission from animals to humans at petting zoos, fairs and other animal exhibits. Olympia, WA: Washington State Department of Health, Office of Environmental Health and Safety, 2001. Available at http://www.doh.wa.gov/ehp/ts/Zoo/RecommendationsPettingZoo.pdf.
99. Commonwealth of Massachusetts Department of Public Health. Recommendations for petting zoos, petting farms, animal fairs, and other events and exhibits where contact between animals and people is permitted. Boston, MA: Commonwealth of Massachusetts Department of Public Health, Bureau of Communicable Disease Control; 2004. Available at http://www.mass.gov/dph/cdc/epii/rabies/petzoo.htm.
100. Animal Exhibition Sanitation Act 211 of 2002. Pennsylvania Bureau of Animal Health and Diagnostic Services. (May 6, 2002). Available at http://www.agriculture.state.pa.us/animalhealth/lib/animalhealth/sb1325p1990-e.coli._act_211_of_2002.pdf.
101. Casemore D. Educational farm visits and associated infection hazards. Commun Dis Rep CDR Rev 1989;19:3.
102. Dawson A, Griffin R, Fleetwood A, Barrett NJ. Farm visits and zoonoses. Commun Dis Rep CDR Rev 1995;5:R81–6.
103. Warshawsky B, Henry B, Gutmanis I, et al. An *E. coli* O157:H7 outbreak associated with an animal exhibit: Middlesex-London Health Unit Investigation and recommendations—executive summary. Middlesex, London, Ontario, Canada: Middlesex-London Health Unit; 1999. Available at http://www.healthunit.com/index.asp?mode=article&lang=english&articleID=10173&rank=380.
104. American Zoo and Aquarium Association. Guide to accreditation of zoological parks and aquariums (and accreditation standards). Silverspring, MD: American Zoo and Aquarium Association; 2005. Available at http://www.aza.org/Accreditation/Documents/AccredGuide.pdf.
105. CDC. Reptile-associated salmonellosis—selected states, 1998–2002. MMWR 2003;52:1206–9.
106. National Center for Infectious Diseases. Healthy pets healthy people. Atlanta, GA: US Department of Health and Human Services, CDC, National Center for Infectious Diseases; 2004. Available at http://www.cdc.gov/healthypets.
107. Midwest Plan Service. Heating, cooling and tempering air for livestock housing. Ames, IA: Iowa State University; 1990.
108. Anderson F, Medus C, Leano F, Adams J, Smith K. Outbreaks of salmonellosis at elementary schools associated with dissection of owl pellets. Programs and abstracts of the International Conference on Emerging Infectious Diseases; March 24–27; Atlanta, GA; 2002:118.
109. McQuiston JH, Childs JE, Thompson HA. Q fever. J Am Vet Med Assoc 2002;221:796–9.
110. Ross C, Morrow PS. Q fever: an issue in occupational health & safety? An overview of the methods of control and the effects of *Coxiella burnetii* on the human host. J R Soc Health 1994;114:151–2.
111. National Association of State Public Health Veterinarians. Compendium of animal rabies prevention and control, 2006. Available at http://www.nasphv.org/83416/index.html.

Appendix A: Hand-Washing Recommendations to Reduce Disease Transmission From Animals in Public Settings

Hand-washing is the single most important prevention step for reducing disease transmission. Hands should always be washed upon exiting animal areas and before eating or drinking. Venue staff should encourage compliance with hand-washing as people exit animal areas.

How to Wash Hands

- Wet hands with running water; place soap in palms; rub together to make a lather; scrub hands vigorously for 20 seconds; rinse soap off hands
- If possible, turn off the faucet by using a disposable paper towel.
- Dry hands with a disposable paper towel. Do not dry hands on clothing.
- Assist young children with washing their hands.

Hand-Washing Facilities or Stations

- Hand-washing facilities should be accessible and sufficient for the maximum anticipated attendance, and configured for use by children (low enough for them to reach or equipped with a stool), adults, and those with disabilities.
- Hand-washing stations should be conveniently located in transition areas between animal and nonanimal areas and in the nonanimal food concession areas.
- Maintenance should include routine cleaning and restocking to ensure 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 pressured water supply is preferable.
- The hand-washing unit should be designed so that both hands are free for hand-washing, by having operation with a foot pedal, or water that stays on after turning on hand faucets.
- Hot water is preferable, but if the hand-washing stations are supplied with only cold water, a soap that emulsifies easily in cold water should be provided.
- Communal basins, where water is used by more than one person, do not constitute adequate hand-washing facilities.

Hand-Washing Agents

- Liquid soap dispensed by a hand or foot pump is recommended.
- Alcohol-based hand-sanitizers may be used if soap and water cannot be made available, and are effective against multiple common disease agents (e.g., *Escherichia coli*, *Salmonella*, and *Campylobacter*). However, they are ineffective against certain organisms (i.e., bacterial spores, *Cryptosporidium*, and certain viruses).
- Hand-sanitizers are less effective if hands are visibly soiled. Therefore, visible contamination and dirt should be removed to the extent possible before using hand-sanitizers.

Hand-Washing Signs

- At venues where human-animal contact occurs, signs regarding proper hand-washing practices are critical to reduce disease transmission.
- Signs that are reminders to wash hands should be posted at exits from animal areas (exit transition areas) and in nonanimal areas where food is served and consumed.
- Signs should also be present to direct all visitors to hand-washing stations upon exiting animal areas.
- Signs with proper hand-washing instructions should be posted at hand-washing stations and restrooms to encourage proper practices.

Example of a Hand-Washing Sign

Directions for Washing Hands	
How - Wet hands with running water - Place soap into palms -Rub together to make a lather - Scrub hands vigorously for 20 seconds - Rinse soap off of hands - Dry hands with disposable paper towels, not on clothing	**When** - After going to the toilet - Upon exiting animal areas - Before eating - Before preparing foods - After removing soiled clothes or shoes

Appendix B: Animals in Public Settings--Information for Visitors

Interacting with animals can be a wonderful experience, both for children and adults. However, healthy animals carry bacteria and other organisms that can sometimes make people sick. People can catch these organisms where animals are present, especially when contact with the animals is encouraged. It is therefore important that all visitors take precautions to avoid illness. This handout summarizes precautions that need to be taken.

Behaviors to Avoid

If a person contacts an animal, the person's hands become dirty and can pick up bacteria or other organisms. If these dirty hands come in contact with the mouth, the person might ingest the organisms and become sick.

In animal areas take the following precautions:

- Don't eat or drink; eating and drinking should occur in designated non-animal areas. Smoking should not occur in animal areas.
- If possible, avoid feeding animals. If feeding animals, use only animal foods.
- Supervise young children closely to avoid hand to mouth behaviors (such as thumb sucking). Toys, pacifiers, spill-proof cups, and baby bottles should not be used.

Hand-washing

Hand-washing with soap and water will clean the hands and prevent illness. It is the MOST important thing that can be done to prevent illness! Hands should be washed after leaving animal areas (regardless if animal contact occurred) and before eating in the non-animal areas. Supervise and assist children with hand-washing.

Populations at High Risk

Some people are at a higher risk of getting sick from bacteria carried by animals in these settings. These people include:

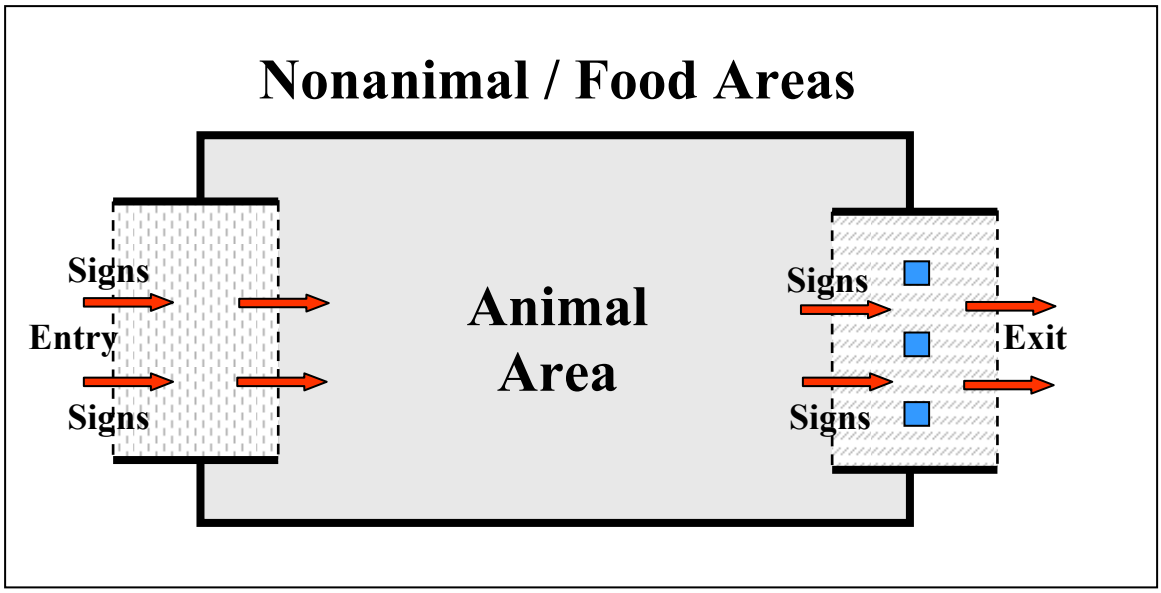
- Young children (especially less than five years old)
- Older adults
- Pregnant women
- Persons who are mentally impaired
- Persons with compromised immune systems

Persons at a higher risk of getting sick should take heightened precautions that include:

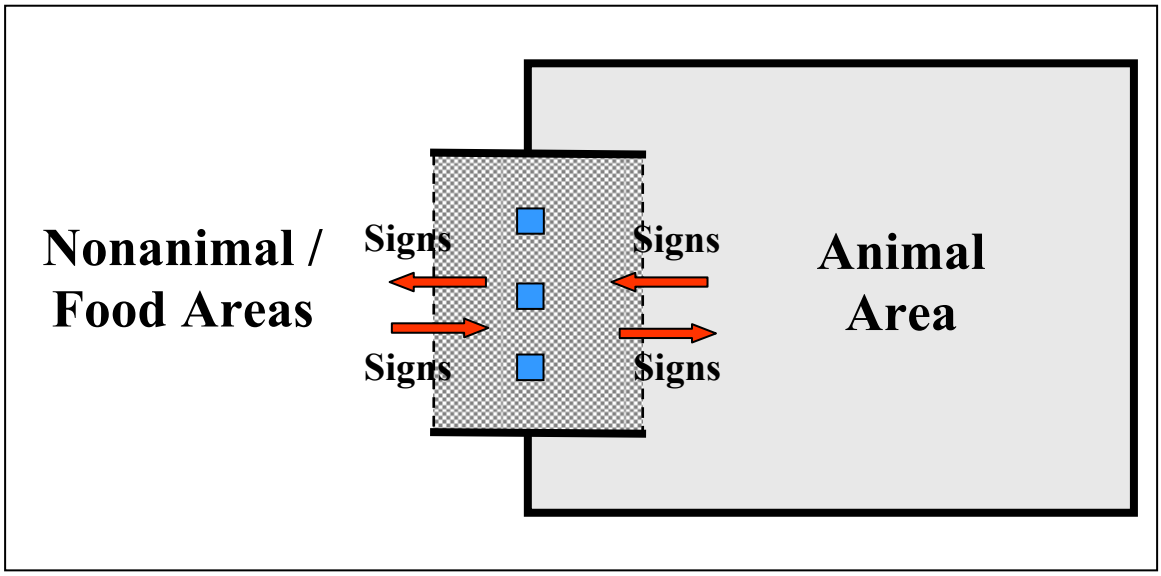
- Thorough and frequent hand-washing.
- Consider avoiding contact with animals and their environment (pens, bedding, manure).
- Avoid animals that are at increased risk of spreading disease, such as young ruminants, young poultry, reptiles, amphibians, and ill animals.

Appendix C: Two Possible Designs for Animal Contact Facilities, with Separate Animal and Non-animal/Food Areas as well as Transition Areas

Design 1



Design 2



Legend

Transition into animal area

Transition out of animal area

Transition into and out of animal area (single entry and exit, Design 2)

Flow of visitors

Hand-washing station

Appendix D: Guidelines for Visiting And Resident Animals In Schools

Animals are effective and valuable teaching aids, but safeguards are required to reduce the risk for infection and injury. These abbreviated recommendations are based on guidelines developed by the Alabama Department of Public Health* and the Kansas Department of Health and Environment.† Recommendations are also available from the National Science Teachers Association§ and the National Association of Biology Teachers.¶

General Guidelines for School Settings**

- Wash hands after contact with animals, animal products, or their environment.
- Supervise human-animal contact, particularly for children aged <5 years.
- Handle and house animals humanely.
- Display animals in enclosed cages or under appropriate restraint.
- Designate areas for animal contact.
- Do not allow animals to roam, fly free, or have contact with wild animals.
- Do not allow animals in areas where food or drink are consumed.
- Clean and disinfect all areas where animals have been present. This task should not be performed by children aged <5 years. Children aged >5 years should only perform this task while supervised by an adult, ideally when children aged <5 years are not present.
- Obtain appropriate veterinary care, a certificate of veterinary inspection, and/or proof of rabies vaccination for visiting animals according to local or state requirements.
- Keep animals clean and free of intestinal parasites, fleas, ticks, mites, and lice.
- Consult with parents to determine special considerations needed for children who are immunocompromised, who have allergies, or who have asthma.

Animal-Specific Guidelines

- Fish — Use disposable gloves when cleaning aquariums, and do not dispose of aquarium water in sinks used for food preparation or for obtaining drinking water.
- Nonpsittacine birds — See General Guidelines.
- Psittacine birds (e.g., parrots, parakeets, and cockatiels)— Consult the psittacosis compendium,†† and seek veterinary advice. Ensure that staff clean cages when children are not present. Use birds treated or testing negative for psittacosis (chlamydiosis).
- Domestic dogs, cats, rabbits, and rodents (e.g., mice, rats, hamsters, gerbils, guinea pigs, and chinchillas) —See General Guidelines.
- Baby chicks and ducks — To prevent *Salmonella* or *Campylobacter* infection, children aged <5 years should not have contact with baby chicks and ducks.
- Reptiles (including turtles, lizards, and nonvenomous snakes) and amphibians — To prevent *Salmonella* infection, children aged <5 years should not have contact with reptiles and amphibians.
- Ferrets — To prevent children aged <5 years from being bitten, they should not have direct contact with ferrets.

- Farm animals — See General Guidelines. Certain animals (e.g., young ruminants and young poultry) excrete *E. coli* O157:H7, *Salmonella*, *Campylobacter*, and *Cryptosporidium* intermittently and in substantial numbers; therefore, meticulous attention to personal hygiene is essential or these animals might not be appropriate in some settings (e.g., particularly for children aged <5 years).

Animals Not Recommended in School Settings

- Wild or exotic animals (e.g., lions, tigers, ocelots, and bears).
- Nonhuman primates (e.g., monkeys and apes).
- Mammals at higher risk for transmitting rabies (e.g., bats, raccoons, skunks, foxes, and coyotes).
- Wolf-dog hybrids.
- Aggressive or unpredictable animals, wild or domestic.
- Stray animals with unknown health and vaccination history.
- Venomous or toxin-producing spiders, insects, reptiles, and amphibians.

* W.B. Johnston, DVM, Alabama Department of Public Health, personal communication, 2002.

† Hansen GR. Animals in Kansas schools: guidelines for visiting and resident pets. Topeka, KA: Kansas Department of Health and Environment; 2004. Available at http://www.kdhe.state.ks.us/pdf/hef/ab1007.pdf.

§ National Science Teachers Association. Standards for Science Teacher Preparation. Arlington, VA: National Science Teachers Association; 2003. Available at http://www.nsta.org/main/pdfs/NSTAstandards2003.pdf.

¶ National Association of Biology Teachers. The use of animals in biology education. Reston, VA: National Association of Biology Teachers; 1995. Available at http://www.nabt.org/sub/position_statements/animals.asp.

** Guide, hearing, or other service animals and law enforcement animals can be used when they are under the control of a person familiar with the specific animal and in accordance with recommendations from the sponsoring organizations.

†† National Association of State Public Health Veterinarians. Compendium of measures to control *Chlamydophila psittaci* (formerly *Chlamydia psittaci*) infection among humans (psittacosis) and pet birds, 2006. Available at http://www.nasphv.org/83416/index.html.

Appendix E: Disinfectants and Properties

All surfaces should be cleaned thoroughly before disinfection. For basic disinfection, a 1:100 dilution of household bleach (i.e., 2.5 tablespoons per gallon) or a 1:1,000 dilution of quaternary ammonium compounds (e.g., Roccal or Zephiran) may be used. For disinfection when a particular organism has been identified, use the table below. All compounds require a contact time of ≥10 minutes. Local or state environmental health officers might have recommendations for appropriate disinfectant selection and precautions for environmental effect. Additional information is available from the Purdue University National Biosecurity Resource Center for Animal Health Emergencies. Available at www.biosecuritycenter.org/dismixchrt.htm.

Chemical compounds used for disinfection, effectiveness of chemical disinfectants against certain organisms, and selected properties of chemical disinfectants that should be considered when used for cleaning and disinfection

Chemical compounds	Chlorine* 0.01–5%	Iodine iodophor 0.5–5%	Chlorhexidine 0.05–0.5%	Alcohol† 70%	Oxidizing agents 0.2–3%	Phenol 0.2–3%	Quaternary ammonium 0.1–2%
Selected products	Clorox®	Tincture/ Provodine	Nolvasan®	Rubbing alcohol	Virkon-S®	pHisoHex®	Roccal-D®
Effectiveness of chemical disinfectants against certain organisms§							
Bactericidal	Good	Good	Good	Good	Good	Good	Good
Bacterial spores	Good¶	Poor	Poor	Poor¶	Fair to good	Poor	Poor
Virucidal	Good	Good	Poor	Fair	Good	Poor**	Poor
Envelope viruses	Yes	Yes	Limited	Yes	Yes	Limited	Limited
Non-envelope viruses	Yes	Limited	No	No	Yes	No	No
Fungicidal	Good	Fair	Fair to good	Good	Fair	Fair	Fair
Protozoal parasites	Fair (concentrated)	Poor	Poor	Poor	Poor	Poor	Fair (ammonia)
Properties of chemical disinfectants††							
Effectiveness in organic matter	Poor	Poor	Fair	Poor	Poor	Good	Poor
Inactivated by soap	No	Yes	No	No	No	No	Yes
Effective in hard water	Yes	No	Yes	Yes	Yes	Yes	No
Residual activity	Poor	Poor	Good	Fair	Poor	Poor	Fair

Source: Adapted from the Nebraska Cooperative Extension and the U.S. Department of Agriculture, 2003.

* Bleach should be diluted to 1:32, mixed fresh daily and replaced whenever contaminated with organic matter (1:32 dilution of 5.75% solution provides > 1500 ppm chlorine).

† Rubbing alcohol is flammable.

§ Effectiveness as a bactericidal, virucidal, or fungicidal agent and effectiveness in eliminating bacterial spores and protozoal parasites: Good indicates effective, Fair indicates some effect, Poor indicates inferior effect; Effectiveness in eliminating envelope and non-envelope viruses: Yes indicates effective, limited indicates moderate effect, no indicates not effective

¶ Alcohol synergistically potentiates the sporicidal effect of hypochlorites (chlorine). Mix 5.75% solution of hypochlorite 1:1 with 50% ethyl alcohol/water. Mix fresh at the time of use and provide contact time of at least 30 minutes.

** 2-phenylphenol (ortho-phenylphenol) is fair.

†† Effectiveness in organic matter: Good indicates effective, fair indicates some effect, poor indicates inferior effect; Inactivated by soap and Effective in hard water: Yes indicates chemical compound has this property, No indicates chemical compound does not have this property; Residual activity: Good indicates chemical compound has residual activity, fair indicates some residual activity, poor indicates inferior residual activity