

BEST PRACTICES FOR DESIGNING AND PLANNING EVENTS WHERE
HUMAN-ANIMAL INTERACTIONS ARE ENCOURAGED, BASED ON OBSERVATIONS
OF RISK BEHAVIORS AND HAND HYGIENE AT SUCH EVENTS

by

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Abstract

Outbreaks of human illness have been linked to visiting settings with animal contact throughout developed countries. These outbreaks demonstrate that although contact with animals in public settings can provide educational and entertainment opportunities, the potential to spread disease exists if risk-reduction tools are not implemented, proper hygiene measures aren't practiced, and precautions are not taken and reinforced. This thesis is divided into two parts. Part one is an observational study of hand hygiene tool availability and recommendations; frequency of risky behavior; and, handwashing attempts by visitors in Kansas and Missouri, U.S., petting zoos. Part two delineates best practices for organizing events where human-animal interactions are encouraged, in hopes it will lower the risk of zoonotic disease transmission. Handwashing signs and hand hygiene stations were available at the exit of animal-contact areas in 10/13 and 8/13 petting zoos respectively. Risky behaviors were observed being performed at all petting zoos by at least one visitor. Frequently observed behaviors were: children (10/13 petting zoos) and adults (9/13 petting zoos) touching hands to face within animal-contact areas; animals licking children's and adults' hands (7/13 and 4/13 petting zoos, respectively); and children and adults drinking within animal-contact areas (5/13 petting zoos each). Of 574 visitors observed for hand hygiene when exiting animal-contact areas, 37% (n=214) of individuals attempted some type of hand hygiene, with male adults, female adults, and children attempting at similar rates (32%, 40%, and 37% respectively). Visitors performed hand hygiene more often when a staff member was present within or at the exit to the animal-contact area (136/231, 59%) than when no staff member was present (78/343, 23%; $P < 0.001$, OR = 4.863, 95% CI = 3.380–6.998), and in petting zoos where animal contact occurred over a fence (188/460, 40.9%) as opposed to

visitors entering an animals' yard for contact (26/114, 22.8%; $P < 0.001$, OR = 2.339, 95% CI = 1.454–3.763). Inconsistencies existed in tool availability, signage, and supervision of animal-contact. Risk communication was poor, with few petting zoos outlining risks associated with animal-contact, or providing recommendations for precautions to be taken to reduce these risks. Recommendations made in the second part of this thesis were based on these observations, recent publications, and the suggestions of many health agencies. It focuses on what event planners can do to design and plan a safer event, and what staff working at the event should be aware of in order to inform visitors and lower the risk of zoonotic disease transmission. Part two discusses two primary tools to reduce risk of zoonotic disease transmission: sanitation and awareness of risk behaviors. Keeping facilities, animals, and visitors clean, and informing visitors of risky behaviors to avoid, while reinforcing positive messages within the animal-contact area, can lower the risk of zoonotic infection. Included with the second part, is a checklist (see appendix A) designed for visitors to assess whether an event that encourages human-animal interaction poses a high or low risk. By identifying possible risk factors, teachers and parents will be able to make an informed decision about the safety of the human-animal encounter.

Table of Contents

List of Tables	vi
Acknowledgements.....	vii
Part 1 – Observation of Public Health Risk Behaviors, Risk Communication, and Hand Hygiene at Kansas and Missouri Petting Zoos – 2010-2011	1
Introduction.....	1
Methodology.....	4
Results.....	5
Discussion.....	8
Tables.....	12
Part 2 – Best Practices for Planning Events Encouraging Human-animal Interactions	13
Designing the Ideal Animal-contact Area	14
Training Staff for Human-animal Contact Events	22
Conclusion	25
References.....	27
Appendix A - Appendix A - Petting Zoo’s Visitors Guide	36

List of Tables

Table 1. Hand hygiene station locations and supplies observed at 13 petting zoos' animal-contact areas in Kansas and Missouri, U.S.....	12
Table 2. Observed visitor behavior in a 30-minute period within 13 animal-contact areas at petting zoo events in Kansas and Missouri, U.S.....	12

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Part 1 – Observation of Public Health Risk Behaviors, Risk Communication, and Hand Hygiene at Kansas and Missouri Petting Zoos – 2010-2011

Introduction

Petting zoo outbreaks demonstrate that although contact with animals in public settings (such as fairs, petting zoos, and schools) can provide educational and entertainment opportunities⁸ the potential to spread disease exists at these events if proper hygiene measures and precautions are not taken and reinforced. Human illness outbreaks have been linked to visiting petting zoos or similar settings with animal contact in the U.S., Canada, U.K., New Zealand, Australia, Ireland and the Netherlands.¹⁹ An October 2011 outbreak of *E. coli* O157:H7 at the North Carolina State Fair resulted in 25 illnesses; an August-September 2009, *E. coli* O157:H7 outbreak at Godstone Petting Farm in the U.K. resulted in 93 illnesses, “*of whom 76 (82%) were under 10 years of age. Of the 78 people with symptoms, 27 (35%) were admitted to hospital and 17 (22%), all of them children, were diagnosed with HUS. Eight of the children with HUS required dialysis, some of whom have been left with permanent kidney damage.*”^{14, 24} U.S. Centers for Disease Control and Prevention (CDC) has documented approximately 150 outbreaks of human infectious disease involving animals in public settings from 1996-2010.⁸ Primary infectious agents of concern in these settings include *Salmonella*, *Campylobacter*, *E. coli* O157:H7 and *Cryptosporidium*.⁸ These infectious agents may be passed in animal feces and transmitted to humans via direct or indirect fecal-oral contact.⁴⁷ The investigation into the Godstone farm outbreak identified evidence of environmental contamination outside the main

barn, indicating acquisition of illness through both direct animal or fecal contact and indirect environmental contact (e.g. contacting railings or soiled footwear).²⁴ Children are at increased risk of infection in animal-contact settings due to certain factors and behaviors, including lack of awareness of the risk for disease, inadequate handwashing, lack of close supervision, and frequent hand-to-mouth activities (e.g., use of pacifiers, thumb-sucking, and eating).⁸

Petting zoos may restrict animal contact to touching or feeding animals over or through a fence, or permit people to enter animal enclosures while petting or feeding animals. These animal-contact settings may be present at state or county fairs, animal swap meets, pet stores, zoological institutions, circuses, carnivals, farm tours and educational exhibits at schools.^{2, 42, 54} Animal species vary, although popular species in the U.S. include goats, sheep, rabbits, llamas, pigs, donkeys, calves, ducklings, chicks, reptiles, and rodents. Ruminants, such as cattle, goats, sheep and deer, can be sources of shiga-toxin producing *E. coli*, including *E. coli* O157:H7, and *Cryptosporidium*, while poultry, such as ducklings or chicks, may spread *Salmonella* spp. and *Campylobacter*.

Although regulations or guidelines for petting zoos exist, they vary by local and state health departments. Since 2000, both Pennsylvania (Act 211 of 2002) and North Carolina (Aedin's Law of 2005) have passed legislation for animal-contact venues.³³ Both the CDC and U.K.'s Health Protection Agency^{8, 29} suggest handwashing is the most important prevention step for reducing disease transmission in animal-contact settings. Authorities also recommend that venue staff encourage handwashing to visitors exiting animal-contact areas.⁸ U.K. health officials currently recommend handwashing stations with soap and water only (no wipes or sanitizers).

While some studies suggest inadequate handwashing facilities may have contributed to enteric disease outbreaks,³ or washing hands was protective against illness,^{8, 21, 44} others suggest relevant infectious agents may be aerosolized and inhaled,⁵¹ thus not prevented with handwashing. Handwashing tool selection may also contribute to the success of hand hygiene as a preventative measure, as some outbreak investigations have reported alcohol-based hand sanitizer was not protective against illness, especially when hands are soiled.⁷

Hand hygiene compliance is an additional barrier to disease prevention in animal-contact settings. Studies have shown compliance rates in petting zoos are highly variable, often averaging below 50%, and are dependent on venue layout.^{1, 34, 54} Weese *et al.*⁵⁴ observed hand hygiene compliance by petting zoo visitors at 36 venues in Ontario, Canada. Results indicated hand hygiene compliance rates by visitors at petting zoos varied between 0-77% (mean value 30.9%), and the authors suggested factors associated with increased compliance was availability of hand hygiene stations near the exit, running water, and hand hygiene signage.⁵⁴ A follow-up study by Anderson and Weese¹ used video observation to assess hand hygiene compliance at a temporary petting zoo in Ontario, Canada. Fifty-eight per cent of visitors performed some form of hand hygiene (either using water, soap and water, or hand sanitizer), and two interventions (improved signage while offering hand sanitizer, and verbal hand hygiene reminders by venue staff) were associated with increased hand hygiene compliance.¹

The objective of this study was to characterize public health risk behavior and hand hygiene practices by visitors in Kansas and Missouri petting zoos. Secondary objectives included determining the presence of risk communication tools and hygiene station availability in these zoos.

Methodology

A convenience sample of 13 public events advertising “petting zoo” in Kansas (n=9) and Missouri (n=4) was used for this study. The study was given exempt status from the Institutional Review Board at the authors’ university due to observation of public behavior. All observations were anonymous and no personal information was collected. Petting zoo events were identified through Internet searches and word-of-mouth. Unannounced visits were performed during the autumn of 2010 and summer of 2011. Public petting zoo attractions were located at both temporary and permanent events, including zoos, farms, and pumpkin patches. Information collected included zoo duration (permanent vs. temporary), animal species, types of animal contact permitted, handwashing facilities, signage, hand hygiene, and risk behaviors. Hand hygiene station location was noted in relationship to animal enclosures. Observations were conducted either inside or outside of animal-contact areas, depending on the size and nature of the petting zoo. While conducting behavioral observations, observers were positioned such that visitor actions were in plain view. Behavioral observations were conducted during 30-minute, randomly selected periods in each petting zoo throughout the day. During behavioral observation periods, data were collected on visitor actions deemed to be an infection risk (e.g. eating animal food, animals licking a child’s face) within animal-contact areas. Hand hygiene behaviors of visitors within animal-contact areas were observed for 30 minutes per petting zoo visit, and information collected included gender, age (adult, child), hand hygiene attempt upon exiting the animal-contact area (yes or no), and materials used (sanitizer; soap and water). The number of people exiting an animal-contact area who made an attempt at hand hygiene was recorded and compared with total number of people exiting that area within that 30-minute period. Hand hygiene performed within the animal-contact area (where available) was not recorded, as further

animal contact may have occurred prior to exit. The materials used for each hand hygiene attempt were recorded, but hand hygiene technique was not evaluated.

Statistical analysis – Descriptive statistics were used for summarizing risk behaviors, signage, and hand hygiene tools. Fisher’s exact test was used to test whether a risk factor observed in an animal-contact area was associated with staff presence or specific signage discouraging that behavior. Chi-square analysis was used to analyze whether hand hygiene attempts were different among adults and children, or between adult male and female visitors. Similarly, chi-square analysis was used to determine whether hand hygiene performance was associated with visitors being allowed animal contact by entering animal yards or pet over-the-fence. Chi-square analysis was also used to determine if an association was present between hand hygiene performance and presence of a staff member. Significance was set at $p < 0.05$ for all comparisons.

Results

Animals most commonly present in petting zoos included goats, deer, chicks, ducks, sheep, and cows. Goat kids were particularly popular among petting zoos ($n=11/13$), including 6/7 petting zoos that permitted visitors to enter animal enclosures. Additionally, one petting zoo allowed children to enter, pet and sit among tortoises. Seven out of 13 petting zoos permitted visitors to enter animal enclosures, while the remaining six petting zoos restricted petting/feeding to be done over or through a fence. Twelve petting zoos sold or provided free animal food for direct animal feeding by visitors.

Hand Hygiene – Hand hygiene facilities were available at the exit of 7/13 petting zoos’ animal-contact areas. The remaining six petting zoos had hand hygiene facilities within or near animal-contact areas. Not all facilities were considered adequate. One petting zoo had a sink

without soap, and no sanitizer was available. At another petting zoo, 2/3 sanitizer dispensers were empty and there was no accessible sink or soap for handwashing. A summary of hand hygiene station locations and supplies at animal-contact areas is provided in Table 1.

Eating Areas and Restrooms – Separate eating areas (away from animal enclosures) were noted in 11/13 petting zoos. All observed petting zoos had restrooms available to visitors, and all restrooms were deemed to be in good working condition. Soap, water and paper towels were available in the restrooms of 12/13 petting zoos. Three petting zoos provided instructions for handwashing/sanitizing in restrooms.

Signage – Signs to encourage handwashing were available at petting zoos in the following locations: exit (n=10/13) of animal-contact areas and inside restrooms (n=3/13), but signs were not noted at the main zoo entrance or entrance to eating areas at any visited events. Directions to the location of handwashing stations were provided on signs in four petting zoos. Signs gave instructions to wash hands prior to eating, drinking or smoking (n=3/13), prior to touching animals (n=1/13), after touching animals (n=12/13), after handling animal food (n=4/13), and after using the restroom (n=3/13). Where signs included guidelines for how to wash hands (n=1/13), details included: use soap and running water, and rub hands vigorously for 15 seconds. Other signage near animal-contact areas included instructions: not to feed animals while eating/drinking/smoking (n=4/13); to wash hands prior to touching face (n=1/13); not to eat animal food (n=1/13); not to eat or drink human food in animal-contact areas (n=6/13); and to cover open wounds (n=1/13).

Staff and Animal-contact Area Cleanliness – In six petting zoos (n=6/13) a staff member was present monitoring activity in the animal-contact area; in some petting zoos, a staff member was seen cleaning the yard. In one petting zoo, goat kids were observed escaping through the

fenced enclosure and roaming freely; no staff member was present. All petting zoos observed were deemed to have clean animals (animals appeared well kept and healthy). At petting zoos where visitors were allowed to enter the animal-contact area (n=7/13), small amounts of urine and feces were observed in 5/7 enclosures. No staff member was observed verbally encouraging hand hygiene or discouraging risk-behaviors.

Visitor Behaviors – A summary of observed visitor behavior in petting zoos can be found in Table 2. In total, 496 behavioral observations at 13 petting zoos were made. The most commonly recorded behaviors were visitors touching their hands to their faces and animals licking visitors' hands. No association was identified between hand-touching-face behavior by children (p=0.563) or adults (p=0.216), and presence of a staff member within the animal-contact area; a sign discouraging this behavior was present in 1/13 petting zoos. No association was made between animals licking children's hands (p=0.286) nor animals licking children's faces (p=0.192), and presence of a staff member. However, animals were observed to lick children's hands in 2/6 petting zoos with a staff member present and 5/7 petting zoos without a staff member present. No signs were present in any petting zoo discouraging visitors from allowing animals to lick their hands, but 12/13 petting zoos provided food for visitors to feed animals. Children eating (p=1.0) or drinking (p=0.265) within animal-contact areas was not associated with staff presence, nor were these behaviors associated with signs discouraging them. In one petting zoo, three children were observed picking up animal feces. This site did not have a staff member present, a sign discouraging touching feces, nor available handwashing facilities at the exit of the animal-contact area. The petting zoo where one child was found consuming animal food in an animal-contact area did not have a staff member present nor a sign discouraging this behavior.

Visitor Hand Hygiene – Data for hand hygiene behavior of visitors were recorded from seven petting zoos with hand hygiene facilities at the exit to the animal-contact areas. The hand hygiene behavior of 574 individuals was observed. Adults accounted for 55% (n=316) of observations, consisting of 40% males (n=126) and 60% females (n= 190). Children accounted for 45% (n=258) of observations. A total of 214/574 individuals (37%) made a hand hygiene attempt while exiting the animal-contact area during observation periods. No difference in attempt percentage was noted between adults (n=118/316) and children (n=96/258)(p=1.000) or between adult males (n=41/126) and adult females (n=77/113)(p=0.156). Visitors performed hand hygiene more often when a staff member was present within or at the exit to the animal-contact area (n=136/231, 59%) than when no staff was present in these areas (n=78/343, 23%)(p<0.001). Visitors in petting zoos where animal contact occurred over a fence performed hand hygiene more often (n=188/460, 40.9%) than visitors in petting zoos who were allowed to enter an animals' yard for contact (n=26/114, 22.8%)(p<0.001).

Limitations – Handwashing compliance can be affected by factors that were not assessed in this study, such as peer pressure and layout of the animal-contact area and handwashing stations. More research should be done to see how each affects compliance. A second limitation is an unequal number of visitors observed at each petting zoo. Finally, this report represents observations from Kansas and Missouri petting zoos, and while these petting zoos had characteristics of petting zoos throughout the U.S., results may vary based on geographical location.

Discussion

Seven out of 13 petting zoos allowed visitors to enter the animals' yards, which may increase opportunity for certain risk behaviors (increased contact with animals and exposure to

feces and other waste) and exposure to infectious organisms. Disease transmission may occur through direct contact with animals or animals' waste, as was the case with a 2004 North Carolina outbreak which affected 108 people;⁷ indirectly through contact with surroundings (such as fencing);²⁴ or even aerosolization as observed in an *E. coli* O157:H7 outbreak at a county fair in Oregon, in which 60 people fell ill.⁶ Small amounts of urine and feces were observed in 5/7 petting zoos where visitors were allowed to enter animal yards. This may be of concern with young children, specifically toddlers, who may fall down frequently;³⁶ when visitors are permitted to bring items such as bottles, pacifiers, food or toys into animal enclosures; or for immunosuppressed individuals. Animal hygiene was observed in this study, and all visited zoos were deemed to have clean animals (animals appeared well kept and healthy). Although this was a positive finding, it may provide little reassurance, as animals infected with enteric pathogens may show no signs of illness, and pathogens may be shed intermittently.³⁴ Additionally, animals considered to be of a particularly high risk of disease shedding generally include young ruminants, young poultry, reptiles, amphibians, and ill animals.⁸ In this study, young ruminants, young poultry and reptiles were among animals encountered at zoos. Goat kids were particularly popular among petting zoos (11/13), including 6/7 zoos that permitted visitors to enter animal enclosures. Additionally, one petting zoo allowed children to enter, pet and sit among tortoises. CDC's Animal-Specific Guidelines recommends against this type of exposure due to risk of acquiring *Salmonella* from reptiles: "*Do not keep reptiles (turtles, snakes, lizards) in facilities with children aged <5 years, nor should children aged <5 years be allowed to have direct contact with these animals.*"^{4, 8}

Public health risk behaviors were observed being performed by at least one visitor in all (n=13) petting zoos visited. These behaviors may put visitors at risk of acquiring a zoonotic

disease. Although touching hands to face within the animal-contact area was the most frequently noted behavior, one child was observed picking up animal feces, and one child was seen eating animal food. Frequent hand-to-mouth behavior, such as sucking on pacifiers, eating, or drinking within animal-contact areas, has been shown to increase the risk of *E. coli* acquisition in children.³⁶ In 2004-2005, two separate outbreaks of *E. coli* O157:H7, located in North Carolina and Florida, resulted in over 187 combined illnesses. In both outbreaks, extensive direct animal contact and behaviors such as falling or sitting on the ground or using a “sippy” cup within enclosures were associated with illness.⁷ During an outbreak of *E. coli* O157:H7 at the Western Fair in Ontario, Canada, it was noted that animal feed provided to visitors in edible ice-cream cones may have contributed to disease transmission.⁵² Risk communication tools and hygiene stations are essential to inform visitors of potential risks and facilitate compliance of public health recommendations. Both varied greatly in Kansas and Missouri petting zoos.

While most permanent petting zoos (9/11) had soap and water available, not all petting zoos (7/13) had paper towels and some (mostly temporary petting zoos) had only hand sanitizer. Yamamoto *et al.*⁵⁷ found paper towels to be more effective for removing bacteria from fingertips than palms and fingers; paper towels are also less likely to spread bacteria and contaminate the surroundings when compared with hot air driers or jet air driers.⁴³ Petting and feeding animals allows for organic material to contaminate hands, lowering efficacy of alcohol-based hand sanitizers against pathogens. CDC⁸ and HPA²⁹ recommend handwashing with water and soap as the best method of hand hygiene. CDC categorizes alcohol-based hand sanitizers as a hand-sanitizing agent, but recommends these be used only when soap and water are not available, as sanitizers are less effective on visibly soiled hands.

Overall hand hygiene compliance upon exiting animal-contact areas was poor in this study (n=214/574, 37%), and consistent with findings (31%) by Weese *et al.*⁵⁴ at Ontario petting zoos. Increased handwashing compliance with the presence of a staff member, suggests that the oversight has a direct, positive impact on visitors' hand hygiene compliance. An individual's behavior has been shown to change when he or she is aware of being watched.²³ Similarly, peer pressure has been reported to improve hand hygiene.^{55,56} Visitors in petting zoos where animal contact occurred over a fence also performed hand hygiene more often than visitors in petting zoos who were allowed to enter an animals' yard for contact, which may have been impacted by availability or location of hygiene stations or presence or location of signs. Other factors that may influence hand hygiene compliance include understanding of public health risks involved with animal-contact, and understanding of the benefits of handwashing in minimizing these risks. More research is needed in this area to understand how these factors relate to each other and influence hand hygiene compliance to identify targets where behavior changing interventions and methods could be applied.

While the presence of a staff member appears to increase hand hygiene compliance, it appeared to have no effect on reducing risky behaviors. While educational signs have the potential to convey risks and encourage hand hygiene,¹⁶ no effect was seen in this study and further research into ideal content and location of signage in petting zoos may be warranted. Building on Anderson and Weese's¹ findings, this study supports the importance of amending current best practice guidance to explicitly include suggestions that a staff member be located in animal contact areas to passively and actively encourage hand hygiene as well as risk-reduction behavior.

Tables

Table 1. Hand hygiene station locations and supplies observed at 13 petting zoos’ animal-contact areas in Kansas and Missouri, U.S.

	Hand hygiene station	No. of zoo events
Location	Within premises	13
	Exit of animal-contact area	7
Supplies	Running water	11
	Soap (bar or pump)	11
	Disposable paper towels	7
	Hot air dryers	3
	Waste containers	9
	Alcohol based hand sanitizer	6

Table 2. Observed visitor behavior in a 30-minute period within 13 animal-contact areas at petting zoo events in Kansas and Missouri, U.S.

Observation	No. of zoo events (%) [observed individual behaviors]
Children touching hands to face	10 (77%) [n = 107]
Adults touching hands to face	9 (69%) [n = 53]
Animals licking children’s hands	7 (54%) [n = 44]
Animals licking adults’ hands	4 (31%) [n = 36]
Animals licking children’s face	2 (15%) [n = 11]
Children eating human food	2 (15%) [n = 2]
Children drinking	5 (38%) [n = 21]
Adults eating human food	2 (15%) [n = 6]
Adults drinking	5 (38%) [n = 24]
Children eating pet food	1 (7%) [n = 1]
Children picking up feces	1 (7%) [n = 3]
Children sucking on pacifier	3 (23%) [n = 6]

Part 2 – Best Practices for Planning Events

Encouraging Human-animal Interactions

As a follow-up to this observational study, other observational studies in the literature, and the many reported outbreaks of disease from human-animal contact in petting zoos, Part 2 of this thesis was performed to design guidelines and best practices for petting zoo design and for minimizing risk of disease transmission during interactions. In addition, a checklist was also developed for visitors as well as organizers, such as parents and teachers, to use when planning to attend such events in hopes it will allow them to make a more informed decision as to which events pose a lower risk. Although didactic in nature, events encouraging human-animal interaction introduce the possibility for zoonotic disease transmission.^{8,28} Zoonotic diseases can be caused by bacteria, viruses, protozoa, and parasites. A recent study estimated 14% of all diseases in the U.S. caused by *Campylobacter* spp., *Cryptosporidium* spp., Shiga toxin-producing *Escherichia coli* (STEC) O157, non-O157 STECs, *Listeria monocytogenes*, nontyphoidal *Salmonella* spp., and *Yersinia enterocolitica* were attributable to animal contact.²⁶ These pathogens are of most interest due to their ability to cause illnesses and because they are commonly found in, and shed by, healthy, or asymptomatic animals.⁸

Amongst the most recent and largest outbreaks of zoonotic diseases related to human-animal interaction are: an October, 2012 STEC *E. coli* outbreak at the Cleveland County Fair in North Carolina;⁴⁰ a July, 2012 Influenza A (H3N2) virus outbreak in humans and pigs at an Indiana County Fair;¹⁵ an October, 2011 *E. coli* O157:H7 outbreak at an animal display area at the North Carolina State Fair;¹⁴ a 2004 *E. coli* O157:H7 outbreak linked to a goat and sheep

petting zoo at the North Carolina State Fair;^{8, 14} an August-September, 2009 *E. coli* O157:H7 outbreak at Godstone Petting Farm in the U.K.;^{24, 31} and, New Zealand's first reported cryptosporidiosis outbreak associated with human-animal interactions at a two-day farm educational event in Wellington in 2000.⁴⁶ Multi-state outbreaks of *Salmonella* spp. associated with domestic turtles,¹² live poultry,¹³ and African dwarf frogs⁹ further demonstrate the broad nature of this public health issue and risks involved with human-animal interactions at petting zoos, schools, and at home. These outbreaks combined add up to a total of two deaths and more than 1,100 illnesses, emphasizing the need for better event organizer compliance, enforcement, and verification of policies, laws, and recommendations made by governments and health organizations (e.g., U.S. Centers for Disease and Prevention, U.K. Health Protection Agency). The objective of this second part is to delineate best practices for organizing events where human-animal interactions are encouraged, lowering the risk of zoonotic disease transmission.

Designing the Ideal Animal-contact Area

Animal-contact area's entrance, exit, transition zones, and service access point – Ideal animal-contact areas have: a dedicated visitor entrance and exit with transition zones; a separate service access point; and, are isolated from the rest of the zoo, fair, event, or classrooms.^{8, 28} To encourage handwashing before and after contact with animals, visitor flow should preferably be one-way.⁸ No visitor should be able to visit other parts of the event from within the contact areas without passing through an exit that includes a hand hygiene station.^{18, 28} Automatic (or foot-operated) washing stations, soap dispensers, and paper towel dispensers, are the preferred options to lower the risk of cross-contamination.^{25, 27} Wipes, or anti-bacterial gels are not effective in the presence of organic material and are not an acceptable substitute for proper

handwashing.^{8, 28, 29} Wipes and gels can be used as an additional precaution following handwashing and, if used prior to petting animals, can reduce transmission of disease from humans to animals.

Transition zones, defined as a geographical buffer zone located directly before the visitor entrance to the animal-contact area, and immediately before or after the visitor exit, are an effective location to promote hand hygiene awareness and practice.⁸ The entrance transition zone should focus on awareness, and informing visitors about risks involved with animal contact and how to reduce risks, while encouraging handwashing prior to and after being in contact with animals or entering the area. In two previous studies, signage, staff presence and verbal encouragement were observed to have a positive impact on hand hygiene,^{1, 18} and are therefore recommended at both transition zones.⁵³ Information within the exit transition zone should be geared toward hygiene, including an appropriate number of handwashing stations (based on maximum occupancy) accessible to all visitors regardless of age or height and equipped with running water, soap, paper towels and trash bins.^{8, 28} As mentioned in Part I, visitors were 4.8x more likely to wash their hands when a staff member was present within or at the exit to the animal-contact area (136/231, 59%) than when no staff member was present (78/343, 23%; $P < 0.001$, OR = 4.863, 95% CI = 3.380–6.998).¹⁸

A service access point, inaccessible to visitors, should be designed into the animal-contact area to allow movement of animals in and out of the area, for transporting animal feed, waste, and other potentially pathogen-containing materials without the risk of contaminating visitor areas, fence rails and walkways.²⁸

Animal-Contact Areas – It is ideal to keep animal-contact areas isolated from other general public areas at the event by an outer physical barrier (e.g., fence, wall). All animals,

animal housing (permanent or temporary), and animal hygiene tools should be housed within these animal-contact areas. Visitor walkways through the animal-contact area and animal pen floors should be made of a material that allows for effective daily cleaning and sanitation, while reducing self re-infection (e.g., slotted metal panels for walkways and concrete with bedding for pens), rather than dirt.⁴⁵ Animals should be confined to a specific petting pen by a fence that allows human-animal interaction and/or feeding while restricting the animals from coming into direct contact with visitors' walkways or areas.^{8,28} An isolation area for sick or stressed animals should be available within the animal-contact area, but restricted to visitors, to house such animals until further recommendations are made by the veterinarian, or the animal has become calm and is ready to return to its petting pen. Double metal fencing is best used to separate animals from visitors,²⁸ because it is easy to clean and sanitize. If metal is not an option, wooden fences should be varnished to create a smooth surface, facilitating cleaning and sanitation.

An unpublished study by Evers *et al.*²⁰ in the Netherlands, found cleaning fences would lower the risk of zoonotic disease transmission. A scenario of 90% reduction of *Campylobacter* contamination gave an 82% reduction in the number of petting zoo *Campylobacter* cases in people.²⁰ The CDC⁸ recommends all surfaces at animal-contact areas (e.g., walkways, fencing, faucets, sinks) should be thoroughly cleaned on a daily basis to remove organic matter, and disinfected with a 1:32 dilution of household bleach (e.g., one-half cup bleach per gallon of water). Quaternary ammonium compounds can also be used per the manufacturer label. Additional guidelines for eliminating specific organisms can be found at <http://www.cfsph.iastate.edu/disinfection>.⁴⁹ Most compounds require removal of organic material followed by at least ten minutes of contact time with the contaminated surface for effective disinfection.⁸

Although feeding animals is an attraction for many petting zoos, this activity is not recommended due to safety concerns – it may put visitors at an increased risk for zoonotic disease transmission via the fecal-oral route and to physical injury from bites. Animal feed and water should not be accessible to visitors. *E. coli* O157:H7 has been shown to survive for up to 60 days in grass hay feed.¹⁷ If food products are provided to visitors to feed the animals, this should be done in non-edible containers to prevent visitors from ingesting these foods themselves. Animal feed provided in edible ice cream cones may have contributed to an *E. coli* O157:H7 outbreak at the Western Fair in Ontario, Canada.^{8, 52}

When designing an animal-contact area, especially in temporary events, geographic features such as slope, elevation, and water flow through that area should be taken into consideration to prevent or lower animal runoff being carried by rainfall or wind. Mud has been associated with gastrointestinal disease outbreaks demonstrating *Campylobacter jejuni*'s ability to survive and cause disease via this medium.^{35, 48} A study by Islam *et al.*,³² found *E. coli* could survive in soil for more than five months post-contamination, regardless of the method of contamination (contaminated compost vs. contaminated irrigation water). When planning temporary events at schools, the event should not take place where children may play (e.g., playground, yards, sport courts); these areas may remain contaminated for months.⁵¹ A shed, or storage area, with all tools necessary for management, maintenance, and sanitation of animals and their areas should be located within the animal-contact area but isolated from visitors.²⁸

Animal Hygiene and Bedding – Animals should be kept clean, and manure and urine removed promptly^{8, 28, 53} via the service access point (rather than through a visitor entrance or exit). Bedding should be replaced on a daily basis to minimize animal and environmental contamination,⁵³ and housing, fencing, and walkways cleaned and sanitized daily.^{8, 28} A review

of the 2009 Godstone Petting Farm (U.K.) outbreak by Ihekweazu *et al.*³¹ found that the heavily infected barn related to the outbreak had not replaced the deep straw used as animal litter for at least two months prior to the outbreak. It was also observed that public walkways could become contaminated with bedding spilling over from animal pens.³¹ Although no studies have been performed assessing *E. coli* survival in straw, it has been shown that *E. coli* O157:H7 can survive in cedar chip bedding for 35 days, and that bovine urine, at room temperature (25° F), can support *E. coli* O157:H7 growth in such a medium better than water.¹⁷ In a similar study, Varma *et al.*⁵¹ found that *E. coli* O157 could survive for up to 42 weeks in sawdust.

Davis *et al.*¹⁷ found bedding was the most frequently culture-positive sample for *E. coli* O157:H7, followed by water samples from animal water buckets, hair coats (three samples tested positive, one collected while animal fecal sample was negative), and one feed bunk sample (collected while animal fecal sample was also positive).¹⁷ This underscores the importance of keeping animal bedding clean and fresh, and preventing visitors from having direct access to animal feed, water, or their pens.

Non-Contact Areas – Non-contact areas are all areas not considered to be an animal-contact area, and include other areas of the zoo with exhibition animals not directly accessible to visitors for purposes other than observing. No animals from the petting area or wild animals (e.g. squirrels, birds) should be allowed to roam freely in non-contact areas.^{8, 28} Service animals should be allowed in all areas accessible to visitors, and are expected to be on leash and supervised by their handlers at all times. Kitchens and any areas where human food is being prepared should be completely isolated from the outside, preventing all types of animals from entering, including birds, squirrels, insects and service animals.⁵⁰ Where possible, eating lounges, cafeterias, and restaurants, should also be enclosed. Trash bins should be large enough

to accommodate all trash produced by visitors, and fully closed trashcans should be used to prevent birds and other animals from gathering, eating garbage, and contaminating the area with feces.²⁸ Food for human consumption should be prepared, cooked, distributed, and sold only in non-animal areas. Bathrooms equipped with handwashing stations should be located nearby, or directly attached to where food is sold, served, and/or consumed by visitors and staff.⁸ Eating areas should be located as far from animal-contact areas as possible and preferably at the end of any farm trail, walk, or guided walkway.²⁸

Safe Areas – Safe areas are defined as pre-determined areas located near, not immediately next to or attached to, the animal-contact areas where personal items such as strollers, diaper bags, and other similar belongings can be temporarily stored to prevent them from becoming contaminated with pathogens while visitors enter the animal-contact area. Although exact numbers were not noted, Erdozain *et al.*¹⁸ observed visitors storing items in such safe areas regularly at events where such areas were provided. For visitors requiring a wheelchair, the visitor's personal wheelchair can be stored in the safe area, and a separate wheelchair provided within the safe area can be used for animal-contact visitation, to avoid potential contamination of their personal wheelchair.

Staff Availability – Trained staff (either paid or volunteer) should be available at the entrance, within, and at the exit of the animal-contact area.^{8,28} Their role is to inform visitors about risks associated with human-animal interactions; how to minimize those risks; to answer any questions visitors might have; to encourage safe behaviors; to demonstrate and explain proper hand hygiene; and, to discourage any risky behaviors from taking place.²⁸ The presence of staff has been shown to positively impact visitor hand hygiene compliance.^{1, 18} Further research is needed to determine how the presence of staff influences visitors' other risky behaviors.

Within the animal-contact area, staff should remind visitors of appropriate behaviors and enforce the event's guidelines (see "Event Guidelines" section below).²⁸ Staff should keep the contact area clean and ensure that the animals stay within their designated petting pens.

Signage – Signage encouraging hand hygiene should be placed at each of the event's main entrance, animal-contact entrance and exit, transition zones, and within contact areas, making sure they are always facing visitors as they move through the animal-contact area.²⁸ Signage with risky behaviors to avoid should be present at entrance, entrance transition zone, and within the contact area to support staff's verbal efforts.²⁸ Anderson and Weese¹ observed signage to have a positive impact on hand hygiene.

Event Guidelines – These guidelines must be enforced by staff and reinforced by signage. The event's main entrance and entrance transition zones are the best places to inform visitors of these guidelines, and staff inside the animal-contact area should remind visitors and enforce the guidelines. The main rules and guidelines include:^{8, 28, 41, 52, 53}

- human food and drinks are prohibited in animal-contact areas;
- human food should only be sold and consumed at human eating areas (see above) – these areas should be as far from animal-contact areas as possible;
- children under the age of 5 and mentally impaired visitors should not be allowed into animal-contact areas unless carried by, or closely supervised by, an adult at all times;
- toys, strollers, pacifiers, spill-proof cups, baby bottles or similar personal items are prohibited in animal-contact areas;
- smoking, or any tobacco product use, is prohibited in animal-contact area;
- hand-to-mouth behaviors, especially in children (e.g. thumb-sucking, nail-biting) is discouraged;

- visitors should not kiss animals;
- visitors should not have direct contact with manure, urine, or soiled bedding;
- sitting, laying, or playing on the ground is prohibited;
- hands should be washed immediately upon soiling;
- animal feed, water, waste, and other tools should be kept away from visitors' reach; and,
- if animal food is sold or provided, do so in a disposable container, never in edible containers.

Types of Animals – Any event, regardless of setting, should operate under the premise that all animals carry zoonotic pathogens as part of their normal flora, and can therefore infect humans even when asymptomatic.^{8,28} Ruminants (e.g., cattle, goats, sheep) can carry *E. coli* O157:H7, *Cryptosporidium parvum*, non-O157 STEC, *Salmonella enterica* serotype Typhimurium, and *Campylobacter jejuni*.⁸ Davis *et al.*¹⁷ found that all of their animals appeared healthy (asymptomatic) during their study, even after orally inoculating them with *E. coli* O157:H7. They also found these inoculated animals could shed *E. coli* in a range from less than one week to more than one month, and that environmental samples were frequently culture-positive when cattle feces were culture negative.¹⁷

Reptiles (e.g., turtles, snakes, lizards), amphibians (e.g., frogs, toads, salamanders), and poultry (e.g., chicks, ducklings) are more commonly associated with *Salmonella* spp.^{10,11,12,13} Hydeskov *et al.*³⁰ found prevalence of *Salmonella* Eastbourne to be 35% overall (and by far the most common serotype across all zoo's reptiles) at the Copenhagen Zoo. Reptiles at the Education Department of the Copenhagen Zoo, which are constantly being handled by visitors, had a significantly higher prevalence (64%, 35/55) than those reptiles at the main reptile collection (23%, 34/145).³⁰

Petting animals should be limited to adult goats, sheep, cows, ponies, dogs, cats, and rabbits.⁸ Animals at higher risk of clinical or subclinical infection (e.g., turtles, chicks, chickens, ducklings, ducks), inherently dangerous animals (e.g., lions, tigers, snakes), nonhuman primates, mammals at higher risk for transmitting rabies (e.g., raccoons, skunks, bats), venomous or toxin producing spiders, reptiles and amphibians, along with newly born or sick animals, should be avoided.^{8, 28}

Training Staff for Human-animal Contact Events

Staff working at events encouraging human-animal interaction should be trained on how to deal with direct physical injuries (e.g., bites, kicks) and zoonotic disease transmission (e.g., *E. coli*, *Salmonella* spp). Staff should become familiar with hazards, consequences, and risk control measures in order to value the importance of ensuring patron actions are taken.

Although physical barriers and proper design should minimize the risk for kicks and other major physical injuries, accidental bites and visitor falls are still possibilities, especially in those events that allow animals to roam freely within the petting area. Staff should be trained on basic first aid care and to determine when to attend to the issue or contact additional help (i.e., call for paramedics or an ambulance).⁸

Zoonotic disease transmission can occur via indirect or direct routes, which were both considered factors at the Godstone outbreak in the U.K.²⁴ CDC⁸ and HPA²⁹ suggest handwashing is the single most important prevention step for reducing disease transmission in animal-contact settings and recommend hands be washed upon exiting animal-contact areas and before eating or drinking. Although prevalence of *Salmonella enterica* subsp. *enterica* serovar Eastbourne in Copenhagen Zoo reptiles was 35%, and significantly higher at the Zoo's Education Department

(64%), no human outbreaks have ever been recorded in Denmark.³⁰ The authors attribute this to: *“hygiene procedures followed in the Zoo’s Education Department are sufficient to reduce the risk, and these measures should be emphasized whenever reptiles are handled by children.”*³⁰

Staff should encourage visitors to wash their hands and demonstrate how to properly do so after touching or feeding animals; after having entered or touched any of the physical barriers surrounding the animal-contact area; and as they exit the contact area, whether they pet an animal or not.²⁸ Proper handwashing includes wetting hands, applying soap, rubbing until a thick lather forms (at least 15 seconds), rinsing with a significant flow of running water, and drying with paper towels, trying to avoid drying hands on clothes.^{8, 28}

Risky behaviors to recognize and discourage include anything that would facilitate the ingestion or aspiration of pathogens, such as: eating, drinking, smoking, or touching hands to face within contact areas. As previously discussed in part I, there was at least one visitor performing a risky behavior at each of 13 zoos we visited, with the most common behaviors being: children (10/13 zoos; n=107) and adults (9/13 zoos; n=53) touching hands to face within animal-contact areas; animals licking children’s (n=44) and adults’ (n=36) hands (7/13 and 4/13 zoos, respectively); and children (n=21) and adults (n=24) drinking within animal-contact areas (5/13 zoos each). Amongst the high-risk behaviors more commonly observed are:^{8, 18, 28}

- hand-to-mouth;
- hand-to-face;
- kissing animals;
- animals licking visitor’s hands or face;
- contact with any animal’s hind end (risk of infection and physical injury);

- direct contact with animal bedding, particularly if it is grossly contaminated with feces or urine;
- eating, drinking or smoking within animal areas; and,
- use of any other item that goes in the mouth (e.g., bottle, pacifiers, toys, etc.).

Staff members are recommended to inform visitors of risks involved and discourage any of the above risk behaviors²⁸ by specifically mentioning the following key points to visitors before entering the animal-contact area:

- bacterial infections acquired from animals can lead to severe illness and symptoms, such as nausea, vomiting, abdominal cramps, bloody diarrhea, and in severe cases, even death;^{37, 38, 39}
- although all visitors are at risk of both physical injury and zoonotic disease infection, individuals at higher risk include – children under the age of five, pregnant women, individuals over the age of 55, immunocompromised individuals (e.g., people with HIV/AIDS; undergoing cancer treatment; organ transplant recipients), and people who are mentally impaired;
- proper behavior and handwashing can significantly reduce the risks of physical injury and zoonotic disease infection;^{8, 29}
- never insert arms into an animal’s pen, as it may become lodged between the animal and pen, causing injury;
- if feeding is allowed, always do so with a flat hand, where all fingers are extended and kept tightly together side by side; and,
- under no circumstance should anyone pull or push an animal, or any part of an animal (e.g., ears, wool).

If a petting zoo is designed in a way that allows animals to freely roam amongst visitors within the petting area (it's highly recommended they don't), make sure visitors:

- approach animals from front and sides where the animals can see them, never from behind;
- never corner an animal, and only pet animals on neck and back, avoiding areas near the mouth and hind of the animal to avoid bite and kick injuries; and,
- always speak with a low, calm voice, and avoid making loud, sudden noises and movement that might scare animals off.

Conclusion

These guidelines are designed to encourage event planners, designers, organizers, and visitors to reduce risks associated with animal educational activities. Potential visitors, educators, and operators should be able to use the attached checklist to determine which events pose a lower risk (Appendix A).

There are two primary tools to reduce risk of zoonotic disease transmission: sanitation and awareness of risk behaviors. Keeping facilities, animals, and visitors clean, and informing visitors of risky behaviors to avoid, while reinforcing positive messages within the animal-contact area, can lower the risk of zoonotic infection.

As simple as that sounds, we found that of the 574 visitors observed for hand hygiene compliance, only 37% (n=214) attempted any type of hand hygiene. Weese *et al.*⁵⁴ observed a hand hygiene compliance of 0 to 77% (mean value 30.9%) at 36 petting zoos and 58% in a follow-up study¹ at a petting zoo in Ontario, Canada. In the latter, improved signage while offering hand sanitizer, and verbal hand hygiene reminders by venue staff were associated with

increased hand hygiene compliance,¹ highlighting the importance of staff presence. We found a similar positive effect of staff presence within, or at the exits of, animal-contact area on hand hygiene, as visitors were 4.8x more likely to wash their hands with the presence of a staff member. Risky behaviors were observed by at least one person at each of the 13 zoos visited.¹⁸ Further research is needed to better understand how to maximize the number of staff present and how to influence visitor behavior. These guidelines and recommendations are a starting point for reducing the risk involved with events that promote human-animal interactions.

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Appendix A - Petting Zoo's Visitors Guide



Petting Zoo's Visitors Guide

Petting zoos – and any events that encourage human-animal interaction – can lead to the transmission of infectious disease. Prior to visiting these types of events, it is a good idea to call the petting zoo or other venue first to inquire about the topics listed below. Remember to always wash your hands prior to and after entering the animal contact area. Never eat, drink, or engage in any activities that would facilitate the transmission of pathogens to the mouth within the animal contact area (i.e., smoking, biting your nails, touching your mouth with your hands).

Low-risk animals – good choice for animal contact

- Adult goats, sheep, cattle and ponies
- Dogs
- Cats
- Rabbits

Higher-risk animals – avoid animal contact

- Juvenile goats (kids), sheep (lambs), cattle (calves) and ponies (foals)
- Reptiles – e.g., turtles, snakes, lizards
- Amphibians – e.g., frogs, toads, salamanders
- Poultry – e.g., chicks, chickens, ducklings, ducks
- Raccoons, skunks, bats – due to risk of rabies transmission

Ideally animal contact areas should have, or be designed, with the following

- Separate visitor entrance and exit
- Design requiring one-way traffic
- Transition zones at entrance and exit
- Separate service access point
- Petting pens holding animals
- Gates or fences over/through which petting and feeding are allowed
- Distinct visitor walkways not accessed by animals, or used to transport animal bedding or animal food
- Isolation from non-animal areas (preferably enclosed by double fencing)
- Prohibition for visitors to eat or drink within its boundaries

Staff members

- Present at entrance, exit, and within animal contact area
- Keep area clean
- Remind visitors of risky behaviors to avoid
- Remind visitors to wash hands upon exiting
- Enforce event's or venue's guidelines and rules

Entrance transition zone has

- Hand hygiene station with running water, soap, and paper towels
- Signage listing risky behaviors to avoid
- Signage encouraging hand hygiene
- Staff member encouraging safe behaviors, hand hygiene, and informing visitors of risks involved with human-animal interactions

Exit transition zone has

- Hand hygiene station with running water, soap, and paper towels; signage; and staff member encouraging hand hygiene

Sanitation

- Area cleaned and sanitized daily
- Animals kept clean
- Urine and feces promptly removed



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1