

Public Veterinary Medicine: Public Health

Risk behaviors for disease transmission among petting zoo attendees

Marcy McMillian, MPH; John R. Dunn, DVM, PhD; James E. Keen, DVM, PhD;
Karen L. Brady, RN; Timothy F. Jones, MD

Objective—To evaluate risk behaviors for transmission of zoonotic diseases at petting zoos during a period without a recognized disease outbreak.

Design—Observational survey with environmental microbiologic sampling.

Sample Population—6 petting zoos in Tennessee.

Procedures—Attendees were observed for animal and environmental contact, eating or drinking, hand-to-face contact, and use of a hand sanitizer. Hands were examined via bacteriologic culture on some attendees. Environmental samples were collected at 3 petting zoos.

Results—991 attendees were observed; of these, 74% had direct contact with animals, 87% had contact with potentially contaminated surfaces in animal contact areas, 49% had hand-to-face contact, and 22% ate or drank in animal contact areas. Thirty-eight percent used hand sanitizer; children had better compliance than adults. Results of bacteriologic cultures of hands were negative for *Salmonella* spp and *Escherichia coli* O157; *Salmonella* spp were isolated from 63% and *E coli* O157 from 6% of environmental samples.

Conclusions and Clinical Relevance—High-risk behaviors were common among petting zoo visitors, and disease prevention guidelines were inconsistently followed. This is an example of the importance of one-medicine, one-health initiatives in protecting the public health. Veterinarians, venue operators, and public health authorities must work together on targeted education to improve implementation of existing disease prevention guidelines. (*J Am Vet Med Assoc* 2007;231:1036–1038)

Contact with animals in public venues such as fairs and petting zoos has important benefits including education concerning animals and animal husbandry, encouraging compassion for animals, and entertainment. However, contact can also lead to transmission of zoonotic disease. During 1991 to 2005, 55 outbreaks associated with animals in public settings were reported.¹ Despite national recommendations aimed at preventing disease associated with animals in public settings,² outbreaks continue to occur.¹

Few data are available regarding behaviors among visitors to petting zoos that may increase their risk of acquiring disease. Outbreak investigations have identified risk factors such as direct contact with animals, hand-mouth activities, eating, and contact with envi-

From the Tennessee Department of Health (McMillian, Dunn, Brady, Jones) and Department of Preventive Medicine (Dunn, Jones), Vanderbilt University School of Medicine, Nashville, TN 37212; and the USDA, Agricultural Research Service, Northern Plains Area, Roman L. Hruska US Meat Animal Research Center, PO Box 166, Clay Center, NE 68933 (Keen).

Presented in part as an abstract at the International Conference on Emerging Infectious Diseases, Atlanta, March 2006.
Address correspondence to Dr. Jones.

ABBREVIATIONS

RR	Relative risk
CI	Confidence interval

ronmental contamination and protective factors such as hand hygiene.^{1,3-8} However, little is known about the prevalence of such behaviors at petting zoos during a period without a recognized disease outbreak.

In a large population-based survey, 5% of respondents reported visiting a petting zoo or farm in the previous 7 days.⁹ It is important to understand potentially high-risk behaviors in animal contact settings to improve interventions and provide effective disease prevention education. Recent efforts to promote cooperation among human and veterinary medicine communities to improve disease prevention and control activities highlight the importance of better understanding such risks.^{10,11} The purpose of the study reported here was to evaluate risk behaviors for transmission of zoonotic diseases at petting zoos during a period without a recognized outbreak. In addition to the observational study, bacteriologic sampling for *Escherichia coli* O157 and *Salmonella* spp was performed at 3 fairs.

Materials and Methods

Behaviors of visitors to 6 petting zoos in Tennessee were observed by volunteers from the Tennessee Department of Health from August through September 2005. Visitors were observed from the time they entered the petting zoo until they exited the animal contact area or until they were observed to have had all of the behaviors of interest.

Observations (yes or no) were recorded for each visitor for the following behaviors in animal contact areas: direct contact with animals, contact with potentially contaminated environmental surfaces, hand-to-face contact, eating or drinking, and hand sanitizer use. Volunteers were instructed to remain discrete while observing visitor behavior. Detailed instructions, including specific definitions of behaviors, were reviewed with all observers.

An adult was defined as anyone who appeared to be > 14 years of age. Contact with animals was defined as touching an animal with any part of the body. Contact with the environment was defined as touching any potentially contaminated environmental surface in the animal contact area (eg, handrails, animal pens, or the ground) with a hand. Eating or drinking was defined as a visitor with food or drink in their hands or putting any inanimate object such as a cigarette, pacifier, or gum into the mouth while in the animal contact area. Hand-to-face contact was defined as a visitor touching their mouth, nose, or eyes or being touched there by another visitor. A different observer assessed hand sanitizer use by all visitors as they exited the animal contact area.

Bacteriologic sampling of hands was performed at 3 petting zoos. Upon exiting the petting zoo, randomly selected visitors were instructed to rub both hands thoroughly with a sterile premoistened hand wipe that was then collected in a sterile container. Wipes were examined via bacteriologic culture for *E coli* O157 and *Salmonella* spp at the USDA laboratory in Clay Center, Neb.

Environmental samples including soil, livestock feces, bedding, and surface swab specimens were collected from animal contact areas at 3 petting zoos where behaviors were observed. Samples were evaluated via bacteriologic culture for *Salmonella* spp and *E coli* O157 at the same USDA laboratory. Isolation of *E coli* O157 included use of selective broth enrichment, immunomagnetic separation, and plating on chromogenic selective agar.

Statistical analysis— χ^2 Tests were used for statistical comparisons. For all comparisons, $P < 0.05$ was considered significant.

Results

Hand contact of various kinds and eating behaviors were observed in 991 visitors at 6 petting zoos in middle Tennessee. The total number of visitors to the petting zoos was unknown. Among those 991 visitors, 731 (74%) visitors touched animals, 858 (87%) had contact with potentially contaminated environmental surfaces, 484 (49%) had hand-to-face contact, and 217 (22%) ate or drank in animal contact areas (Table 1). Rates of eating and drinking varied substantially among

Table 1—Proportion (No. [%]) of observed attendees at 6 petting zoos with various risk behaviors in animal contact areas.

Behavior	Adults (n = 506)	Children (n = 485)
Contact with animals	311 (61)	420 (87)
Contact with environment	402 (79)	456 (94)
Hand-to-face contact	211 (42)	273 (56)
Eating or drinking	130 (26)	87 (18)

venues (range, < 1% to 47%). Hand sanitizer use was observed in 1,700 petting zoo visitors. Of these, 646 (38%) used hand sanitizer on exiting the animal contact areas (range among venues where it was available, 13% to 66%). Hand sanitizer was not available at 1 venue.

Children were significantly more likely than adults to have contact with animals (RR, 1.41; 95% CI, 1.30 to 1.52), the environment (RR, 1.18; 95% CI, 1.13 to 1.24), and their faces (RR, 1.35; 95% CI, 1.19 to 1.54) and less likely than adults to eat or drink in that setting (RR, 0.70; 95% CI, 0.55 to 0.89). Children were also more likely to use hand sanitizer than adults (RR, 1.19; 95% CI, 1.06 to 1.35). None of the observed behaviors differed significantly between males and females, although sex was not recorded for hand sanitizer use observations.

Of 150 bacteriologic cultures of hands, none yielded *Salmonella* spp or *E coli* O157. Both pathogens were isolated from 1 fairground petting zoo, where samples of alpaca, pony, calf, cow, pig, horse, and mule fecal material; pooled material from the floors of sheep, goat, and calf pens, chicken cages, pen railings, seating benches, and hand gel dispensers were collected. *Salmonella* spp were isolated from 20 of 32 (63%) samples including cow and mule feces, calf pen railings, sheep and goat pens, chicken cages, a seating area within the petting zoo, and hand gel dispensers. *Escherichia coli* O157 was isolated from 2 of 32 (6%) specimens, both of which were calf feces. Environmental surfaces (eg, rails and benches) accounted for 10 of 22 (45%) of the samples with positive results.

Discussion

Potentially modifiable risk behaviors for acquiring zoonotic diseases are common among petting zoo attendees. Not surprisingly, most visitors had contact with animals and potentially contaminated surfaces in such settings. The high proportion of visitors observed eating or drinking, having hand-to-face contact in animal contact areas, and failing to sanitize their hands after visiting the petting zoo is disturbing.

The identification of *Salmonella* spp and *E coli* O157 in petting zoos in the absence of an outbreak confirms that petting zoo settings should be assumed to be contaminated when developing and implementing disease prevention interventions. Animals infected with enteric pathogens may have no signs of illness, and pathogens may be shed intermittently. Resulting environmental contamination can be widespread and persistent.^{1,2} Routine testing or treating of animals is not recommended as a reliable means of preventing the spread of infection.²

National recommendations to prevent disease associated with animals in public settings are available,² and

most venues included in the present study were implementing those guidelines to various degrees. All venues with hand-sanitizing gel available had prominently displayed signs encouraging its use. Variations in the placement and number of signs and sanitation stations likely played a role in the wide range of proportions of visitors that used hand sanitizer appropriately. Subjective reports from observers suggested that signs posted higher on walls where children might be less likely to see them and sanitizing stations placed in less convenient locations contributed to markedly less usage. One venue had warning signs regarding the importance of hand sanitizing prominently displayed at the entrance, exit, and throughout the exhibit, with sanitizer dispensers at each animal pen and in an enclosed animal contact area exitway through which all visitors had to pass. At another venue where staff appeared acutely aware of the presence of study observers, staff actively approached exiting visitors to direct them to sanitizer stations. It is of substantial concern that even with such vigorous efforts on the part of operators to encourage compliance, a third of visitors ignored warnings and did not sanitize their hands.

Similarly, rates of eating and drinking varied widely, despite signs prohibiting it in all animal contact areas. In 1 setting at which half the attendees were observed eating or drinking, an unrelated fair exhibit was offering free ice cream treats at the entrance to the petting zoo. Clearly, optimizing visitor safety at animal exhibits requires the coordinated efforts of not only visitors and venue operators but also managers and organizers of event settings.

This study had clear limitations. Venues included in the study represented a small cross-section of the wide variety of settings in which human-animal interactions occur. Limited observational data were collected, with rough estimates of age and observed behaviors that were undoubtedly affected by interobserver variability, potential operator awareness of observers, and the limitations of describing behavior differences in diverse settings that are difficult to describe quantifiably. Despite this, these findings provide important baseline information.

Recent outbreaks associated with petting zoos have substantial legal implications for the industry.¹² Anecdotal reports of difficulty obtaining insurance and of fairs discontinuing petting zoo exhibits are increasingly common, leading to concerns that important opportunities for education and experience with animals may be lost. Contamination of animal environments cannot be eliminated entirely; thus, effective implementation of

existing disease-prevention recommendations is critical to ensure that opportunities for interaction with animals can continue under the safest conditions possible.

Animal contact is a common risk factor for disease outbreaks as well as sporadic infections.² Although modifiable behaviors of petting zoo attendees have been well documented as risk factors in outbreak settings, the present study is the first, to the authors' knowledge, to reveal the ubiquity of such behaviors in nonoutbreak settings. Our findings provide evidence that the current state of implementation of national recommendations for disease prevention is inadequate. The reasons for this are complex. Recent calls to improve the integration of human and animal medicine (the One Medicine concept) highlight the importance of better understanding such risks.^{10,11} Additional studies are urgently needed to systematically identify specific measures that will help venue operators, event managers, and visitors effectively maximize safety in such settings.

References

1. Steinmuller N, Demma L, Bender JB, et al. Outbreaks of enteric disease associated with animal contact: not just a foodborne problem anymore. *Clin Infect Dis* 2006;43:1596–1602.
2. CDC. Compendium of measures to prevent disease associated with animals in public settings, 2005. *MMWR Recomm Rep* 2005;54:1–12.
3. 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;347:555–560.
4. CDC. Outbreaks of *Escherichia coli* O157:H7 associated with petting zoos—North Carolina, Florida, and Arizona, 2004 and 2005. *MMWR Morb Mortal Wkly Rep* 2005;54:1277–1280.
5. CDC. Outbreaks of *Escherichia coli* O157:H7 infections among children associated with farm visits—Pennsylvania and Washington, 2000. *Can Commun Dis Rep* 2001;27:117–120.
6. Friedman CR, Torigian C, Shillam PJ, et al. An outbreak of salmonellosis among children attending a reptile exhibit at a zoo. *J Pediatr* 1998;132:802–807.
7. Smith KE, Stenzel SA, Bender JB, et al. Outbreaks of enteric infections caused by multiple pathogens associated with calves at a farm day camp. *Pediatr Infect Dis J* 2004;23:1098–1104.
8. Varma JK, Greene KD, Reller ME, et al. An outbreak of *Escherichia coli* O157 infection following exposure to a contaminated building. *J Am Vet Med Assoc* 2003;290:2709–2712.
9. CDC. *Foodborne Diseases Active Surveillance Network (FoodNet): population survey atlas of exposures*, 2002. Atlanta: CDC, 2004.
10. Kahn LH, Kaplan B, Steele JH. Confronting zoonoses through closer collaboration between medicine and veterinary medicine (as 'one medicine'). *Vet Ital* 2007;43:5–19.
11. Kahn LH. Confronting zoonoses, linking human and veterinary medicine. *Emerg Infect Dis* 2007;12:556–561.
12. Babcock DW. Legal implications of zoonotic-disease outbreaks at petting zoos and animal exhibits. *J Environ Health* 2006;69:46–47.