



Outbreaks of *Escherichia coli* O157:H7 Associated With Petting Zoos— North Carolina, Florida, and Arizona, 2004 and 2005

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DURING 2004-2005, THREE OUTBREAKS of *Escherichia coli* O157:H7 infections occurred among agricultural fair, festival, and petting zoo visitors in North Carolina, Florida, and Arizona. One hundred eight cases, including 15 cases of hemolytic uremic syndrome* (HUS), were reported in the North Carolina outbreak; 63 cases, including seven HUS cases, were reported in the Florida outbreak; and two cases were reported in Arizona. No fatalities occurred. Illnesses primarily affected children who visited petting zoos at these events. This report summarizes findings from these outbreak investigations, which indicated the need for adequate control measures to reduce zoonotic transmission of *E. coli* O157:H7.

North Carolina

On October 29, 2004, the North Carolina Division of Public Health (NC-DPH) received a report of a cluster of three HUS cases among children who visited a petting zoo at the North Carolina State Fair. Approximately 800,000 visitors attended this fair during October 15-24, 2004. The fair had two petting zoos (petting zoos A and B).

NCDPH notified all local health departments to report cases of diarrheal illnesses. Intensified surveillance identified 108 persons who became ill, with onset after fair attendance and without

other known cause. Eighty-two (78%) reported visiting a petting zoo at the state fair. Median age was 5 years (range: 1-61 years); 64 (59%) were female. Illness onsets were consistent with exposure during the fair dates. Fifty-two (48%) persons reported bloody diarrhea, and 48 (44%) reported fever. Forty-one cases were laboratory-confirmed Shiga toxin-producing *E. coli* (STEC) infections, of which 38 yielded *E. coli* O157:H7 isolates indistinguishable by pulsed-field gel electrophoresis (PFGE). Twenty patients (19%) were hospitalized, and 15 (14%) had HUS diagnosed.

Systematic environmental sampling of the fairgrounds identified extensive *E. coli* O157:H7 contamination at one of two petting zoos (petting zoo B). Analysis of isolates from 30 systematically obtained environmental samples revealed a PFGE pattern indistinguishable from the predominant clinical isolate pattern. No other PFGE patterns from isolates at this site were noted after systematic sampling.

NCDPH, in collaboration with CDC, conducted a case-control study to identify risk factors for infection. Forty-five case-patients and 188 controls were enrolled; these were frequency-matched to cases in three age groups (0-5 years, 6-17 years, and ≥ 18 years). Confirmed cases in the study were those in persons who (1) had laboratory-confirmed *E. coli* O157:H7 infection or clinically diagnosed HUS with onset after October 15, 2004, (2) reported fair attendance, and (3) had illnesses that were not acquired from secondary transmission. Probable cases were those in persons who reported bloody diarrhea (three or more loose stools per 24-hour period) beginning after fair attendance without other known cause and were determined not to have acquired infections from secondary transmission. Controls attended the fair and reported no diarrheal illness through November 7, 2004. Potential controls were identified from a randomized list of

23,972 persons who purchased tickets to the fair online, at kiosks, or in malls. The study questionnaire included items about human/animal interactions, food and beverage consumption, and hygiene practices. Adjusted odds ratios (AORs) and 95% confidence intervals (CIs) were computed for various exposure variables.

No specific food, beverage, or recreational water exposure was associated with illness. Thirty-six (80%) of 45 case-patients visited petting zoo B, which was noted to have extensive environmental contamination, compared with 64 (34%) of 187 controls (AOR = 8.2; CI = 3.6-18.9). This petting zoo contained approximately 100 goats and sheep in an area where visitors could have extensive contact with animals and their bedding. Case-patients reported spending a median of 20 minutes in petting zoo B, compared with 15 minutes for controls ($p = 0.04$). Visits to petting zoo A were not associated with illness.

Among children aged < 6 years who visited petting zoo B, illness was associated with touching or stepping in manure (OR = 6.9; CI = 2.2-21.9). Behaviors such as falling or sitting on the ground (OR = 3.2; CI = 1.1-9.1) and use of a pacifier or "sippy" cup or sucking on one's thumb while in petting zoo B (OR = 11.0; CI = 2.0-55) also were associated with illness. Reported alcohol-based hand sanitizer use was not protective (OR = 1.9; CI = 0.3-10.2). Reported awareness (among adults who accompanied children) of risk for disease from contact with livestock was protective (OR = 0.1; CI = 0.03-0.5).

Florida

In March 2005, Florida health officials identified a cluster of 22 *E. coli* O157:H7 infections, including seven HUS cases, related to attendance at Florida Fairs and Festivals during February 10-21, 2005, and March 3-13, 2005. Early patient interviews identified no common food or water exposure but did implicate a

common animal exposure (i.e., petting zoo attendance). Three implicated fairs had one common animal vendor, an exhibitor of a farm animal petting zoo. The petting zoo owner was contacted on March 24, and the animals (sheep, goats, and cattle) were placed under voluntary quarantine.

Stool samples from suspected cases were sent to the Florida Department of Health (FDOH) Bureau of Laboratories for culture and PFGE typing of *E. coli* O157:H7 isolates. Stool samples also were collected from 36 animals exhibited at two of three implicated petting zoos. Environmental samples were taken from exhibit grounds of implicated petting zoos from the three fairs. Twenty-four human stool samples, six animal stool samples, and 20 environmental samples yielded *E. coli* O157:H7 isolates with an identical PFGE pattern. The implicated farm animals were put under state quarantine by the Florida Department of Agriculture and Consumer Services on April 8.

FDOH intensified surveillance by requesting rapid reporting of suspected *E. coli* O157:H7 infections and HUS cases. Sixty-three patients were identified who had symptoms of *E. coli* O157:H7 infection within 10 days or HUS within 21 days after visiting the implicated fairs and who had no alternate diagnosis to explain their symptoms; of these, 20 (32%) persons had culture-confirmed *E. coli* O157:H7 infection. Four persons had culture-confirmed infection; however, these cases did not meet the case definition.

Median patient age was 4 years (range: 1-63 years); 35 (56%) patients were female. Clinical features included diarrhea in 63 (100%) patients, vomiting in 28 (44%), abdominal cramps in 27 (43%), and fever in 23 (37%). Seventeen patients (27%) were hospitalized, and seven (11%) had diagnoses of HUS (three of the seven patients with HUS did not have *E. coli* O157:H7-positive stool cultures).

Thirty-four ill persons (54%) were reported to have touched at least one cow, sheep, or goat. Twenty (32%) reportedly fed at least one cow, sheep, or goat.

Preliminary analysis of a case-control study that included 34 case-patients and 176 controls (identified from credit card receipts from the fairs and defined as persons who went to the petting zoo and remained well) found a positive association between illness and both direct animal contact (e.g., 71% of case-patients and 47% of controls touched a cow [OR = 4.2; CI = 1.7-10.5]) and indirect (e.g., 33% of case-patients and 12% of controls touched sawdust or shavings [OR = 3.3; CI = 1.4-7.8]) animal contact.

Arizona

In July 2005, two children hospitalized with *E. coli* O157:H7 infection were reported to the Arizona Department of Health Services. Isolates from the two children had indistinguishable PFGE patterns. Both children had visited a zoo in Arizona that contained a petting zoo. No common food or beverage was consumed by the two children at the zoo, and the children were not related. One child had direct contact with petting zoo animals; the second child only had possible contact with exterior railings at the petting zoo. Both children had played in an area immediately adjacent to and downhill from the petting zoo facility. Fifteen of 25 (60%) fecal specimens from petting zoo animals yielded *E. coli* O157:H7; 12 isolates had PFGE patterns indistinguishable from the clinical isolates. Upon notification of the results, zoo officials immediately closed the petting zoo and adjacent play area.

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Editorial Note: *E. coli* O157:H7 causes approximately 73,000 illnesses in the United States annually, leading to an estimated 2,168 hospitalizations and 61

deaths.¹ HUS is a principal cause of acute renal failure among children in the United States and occurs in 3%-7% of *E. coli* O157:H7 infections.² Among patients with HUS, approximately 3%-5% die as a result.² Most cases of diarrhea-associated HUS are caused by STEC, of which *E. coli* O157:H7 has the strongest association with HUS worldwide.³ At least 80% of childhood HUS is attributable to infection with STEC, primarily *E. coli* O157:H7.⁴

The primary animal reservoir for *E. coli* O157:H7 is ruminant livestock, which are asymptotically colonized. The primary route of transmission for *E. coli* O157:H7 is foodborne; however, among 350 *E. coli* O157:H7 outbreaks reported in the United States during 1982-2002, the transmission route for 11 (3%), accounting for 319 cases, was animal contact.⁵ The three *E. coli* O157:H7 outbreaks described in this report, accounting for 173 cases and associated with direct and indirect animal contact at petting zoos, emphasize the need for adequate control measures to reduce zoonotic transmission.

In the North Carolina outbreak, extensive direct animal contact occurred in an area contaminated with manure. In the Florida outbreak, illness was associated with touching and feeding animals and indirect animal contact (e.g., touching sawdust or shavings or visibly soiled clothes or shoes). In the Arizona outbreak, at least one case likely resulted from exposure in the play area adjacent to the petting zoo, where contamination via drainage from the petting zoo was suspected. In certain instances, exposure to *E. coli* O157:H7 might have occurred before petting zoo patrons could practice hand hygiene. Also, exposure from contaminated clothes, shoes, strollers, or other fomites might have occurred before or after hand-hygiene practice.

Experience from these and previous outbreaks^{6,7} underscores the necessity of using sensitive laboratory isolation methods, such as those used in these outbreaks, for detecting *E. coli* O157:H7 from livestock feces and agricultural environmental samples. Had

direct plating methods used for human stool been the only method used to recover *E. coli* O157:H7 from environmental samples, many positive specimens would have been undetected. Because of the multiple, competing microorganisms in livestock fecal material and soil, selective culture conditions, including selective broth enrichment, immunomagnetic separation, and plating on selective media, should be used.⁶

In 2001, CDC issued guidelines to reduce the risk for transmission of enteric pathogens at venues where the public has contact with animals.⁸ In March 2005, the National Association of State Public Health Veterinarians (NASPHV) published recommendations on hand washing, venue design, animal care and management, and risk communication regarding disease transmission for staff and visitors.⁹

Petting zoos are minimally regulated. Guidelines based on the NASPHV compendium were adopted by the North Carolina Department of Agriculture and Consumer Services (NCDACS) after the outbreak. In addition, a law† was enacted in North Carolina in July 2005 that requires sanctioned agricultural fairs to obtain a permit from NCDACS for all animal exhibitions open to the public. The Arizona Department of Health Services adapted the NASPHV compendium recommendations into educational packets distributed to petting zoo operators statewide.

These recent petting zoo-associated *E. coli* O157:H7 outbreaks highlight the need to strengthen control measures for such exhibits to reduce disease transmission and prevent similar outbreaks. To reduce human exposure to manure, revised control measures should be considered, particularly those restricting young children from directly entering open-interaction areas of petting zoos.

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*An acute condition characterized by microangiopathic hemolytic anemia, renal injury, and low platelet count.

†Available at <http://www.ncleg.net/sessions/2005/bills/senate/pdf/s268v4.pdf>.

Mycobacterium tuberculosis Transmission in a Newborn Nursery and Maternity Ward—New York City, 2003

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EVALUATING YOUNG CHILDREN RECENTLY EXPOSED TO AIRBORNE *Mycobacterium tuberculosis* is a public health priority. If infected, children aged <2 years are at high risk for severe tuberculosis (TB) disease (e.g., TB meningitis).¹ In

December 2003, infectious pulmonary TB disease was diagnosed in a foreign-born nurse working in the newborn nursery and maternity ward of a New York City hospital (hospital A); the nurse had declined treatment for latent TB infection (LTBI) after testing positive 11 years earlier. An investigation including medical evaluation of contacts in the nursery and maternity ward was conducted by the Bureau of TB Control (BTBC) at the New York City Department of Health and Mental Hygiene, hospital A, and CDC. This report summarizes the results of that investigation, which determined that approximately 1,500 patients had been exposed to the nurse but the majority could not be located for evaluation. Among those who were tested, four infants had positive tuberculin skin test (TST) results, likely attributable to recent transmission of *M. tuberculosis*. The findings emphasize the difficulty of conducting contact investigations in certain settings and the importance of effective LTBI testing and treatment programs for health-care workers (HCWs) to prevent TB disease and subsequent health-care-associated transmission.

In December 2003, a female nurse (nurse A) working in the newborn nursery and maternity ward at hospital A received a diagnosis of acid-fast bacilli (AFB) sputum smear-positive, non-cavitary pulmonary TB disease. Eleven years earlier, nurse A had LTBI diagnosed with a TST result of 15 mm induration during screening for employment at hospital A, after emigrating from the Philippines. She had elected not to take the isoniazid prescribed for treatment. The reason nurse A gave for declining treatment was that most adults from the Philippines, where TB is endemic, have positive TST results and generally do not take treatment for LTBI. She also stated that the positive TST result might have been caused by her bacille Calmette-Guérin (BCG) vaccination for TB disease at birth or potential exposures while she was employed as a nurse in the Philippines. Nurse A had an annual TB symptom screen on eight other occasions and had one other