Salmonella Typhimurium was isolated from two adult cows and a veterinary pathologist who performed a necropsy examination on one of the cows. The isolates had indistinguishable phenotypic and genotypic characteristics. A splash exposure was the suspected means of transmission of the human infection. Veterinary practices and other at-risk occupations should establish site-specific infection control plans and review recommendations for use of facial protection measures during procedures that may produce splashes or aerosols.

Introduction

Salmonellosis is a common zoonotic and foodborne disease of humans. In the United States, Salmonella infection is estimated to occur in more than 1.4 million individuals each year (Voetsch et al., 2004). The disease is usually spread by direct and indirect fecal–oral transmission and is a recognized occupational risk among veterinary, animal care, and food processing personnel (Cherry et al., 2004; Hendriksen et al., 2004). Hand hygiene, food hygiene, fly control, and surface disinfection are considered to be important practices for controlling Salmonella transmission. At-risk workers are generally advised to take precautions to reduce the risk of transmission by splash or aerosol exposure. However, there have been no reports of human salmonellosis acquired by such means (Centers for Disease Control and Prevention [CDC], 2001). This lack of documented splash or aerosol transmission may result in inconsistent use of personal protective equipment, particularly facial shields or masks. In this report we describe an individual case investigation in which a splash exposure was the suspected source of human enteric salmonellosis.

Materials and Methods

The case

An upper east Tennessee cattle herd of about 40 beef cows with one bull was housed on grass pasture with a farm pond as the principal water source. Starting in mid-October 2006, seven animals (six cows and the bull) were observed in lateral recumbency with bloody diarrhea. Two adult cows died within 48 hours and a third cow aborted several days later. All others recovered. There had been no recent introductions of cattle to the herd and no additional feed had been given to the cattle. Other animals on the farm included three horses in a separate fenced-in area and dogs in a pen downhill from the cows. None of the horses, dogs, or two herd managers became ill. The veterinarian that worked with this farm did not recall similar disease outbreaks in the region during this time period.

A diagnostic necropsy was performed at the University of Tennessee College of Veterinary Medicine on the second cow that died and the aborted fetus. Gross necropsy findings on the cow included diarrhea, dehydration, endocardial hemorrhage, small intestinal ulcers and hemorrhage,
and early pregnancy. Histological examination showed multifocal necrosis in the intestinal mucosa, kidney, liver, and spleen. *Salmonella* was isolated from jejunal mucosal tissues. *Salmonella* was also isolated in high numbers from placenta tissues of the aborted fetus.

During the necropsy examination the gall bladder was opened releasing viscous (normal appearing) bile. While attempting to reach an overhead hose to rinse the bile off, drops of bile were splashed from the glove onto the pathologist’s face. The pathologist’s face and mouth were quickly and thoroughly rinsed with running water in a nearby sink. Three days following the necropsy examination, the pathologist developed intestinal cramps and nonbloody diarrhea. After learning that *Salmonella* had been isolated from bovine tissues taken at necropsy, the pathologist sought medical care. A stool culture obtained from the pathologist also yielded a *Salmonella* isolate. The pathologist’s diarrhea resolved after 2 days without antimicrobial treatment; however, intestinal pain lasted for approximately 2 weeks.

A pathology resident and two veterinary students who participated in the necropsy of the cow did not get sick, in spite of having opened the entire intestinal tract. A second pathologist and set of assistants performed the necropsy on the aborted fetus 10 days later and there were no subsequent illnesses in the attendant individuals.

**Salmonella** isolation and characterization

*Salmonella* isolates were obtained by routine procedures of direct plate and selective-enrichment broth culture at the University of Tennessee College of Veterinary Medicine (bovine isolates from cow necropsy specimen and the aborted fetus) and a commercial medical reference laboratory (Quest Diagnostics-Atlanta, Tucker, GA) (human isolate). Antimicrobial susceptibility tests were performed by the standard disk diffusion method with commercially prepared cation-adjusted Mueller Hinton II Agar Plates and single concentration antimicrobial disks (BBL, BD, Sparks, MD) and/or by commercial microbroth dilution methods (Vitek, bioMérieux, Durham, NC) used in the respective laboratories. Serotypes of the bovine isolates were determined at the National Veterinary Services Laboratory (NVSL, Ames, IA) and the serotype of the human isolate was determined by the Georgia Public Health Laboratory (Atlanta, GA). The three isolates were ultimately sent to the Tennessee Department of Health Laboratory (Nashville, TN) where serotyping and susceptibility testing (Trek Sensititre, Trek Diagnostic Systems, Cleveland, OH) were repeated and pulsed-field gel electrophoresis (PFGE) macrorestriction analysis was performed using the PulseNet USA protocol (http://www.cdc.gov/pulsenet/).

**Results**

The three *Salmonella* isolates (two bovine, one human) were susceptible to all antimicrobials that were tested. The isolates were identified as *Salmonella Typhimurium* (var Copenhagen). Susceptibility test and serotyping results obtained at the Tennessee Department of Health Laboratory were identical to those initially reported. The two bovine isolates and human isolate shared indistinguishable *XbaI* and *BlnI* PFGE macrorestriction patterns. The two-enzyme pattern was indistinguishable from other *Salmonella Typhimurium* in the PulseNet database of human isolates designated by the CDC as multistate cluster 0612MLJPX-1c.

**Discussion**

The same *Salmonella* subtype was isolated from the human, the cow, and the aborted fetus. The index bovine infections most likely represented an isolated outbreak of salmonellosis. There was no record of similar isolates or disease occurrence among other animals in the region. The extent of *Salmonella* shedding among cattle and other animals on this farm was not determined nor was a primary source identified. Of the eight individuals who participated in necropsy examinations on the *Salmonella* infected cattle, only one pathologist reported having subsequent illness. Each person was wearing coveralls, waterproof boots, gloves, and aprons but none were wearing facial protection. Since no other incidents occurred during the necropsy examinations and the extent of participation (and potential exposures to *Salmonella*) was considered to be equal among the individuals, it is reasonable to speculate that salmonellosis in the pathologist was the result of the reported splash exposure.

Workers that handle animals or animal-related products have a greater risk for exposure to *Salmonella* than those in other occupations. Many different activities have potential to cause airborne or splash exposure to *Salmonella* and other notable zoonotic, foodborne pathogens such as...
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*Yersinia, Campylobacter, Listeria, and Cryptosporidium.* The National Association of State Public Health Veterinarians (NASPHV) has recently released guidelines for zoonotic disease prevention in veterinary personnel which recommend that facial protection be used whenever exposures to splashes or sprays are likely to occur (NASPHV, 2006). Furthermore, the NASPHV model infection control plan recommends all personnel present during necropsy examinations wear masks and face shields or goggles. Respirators are recommended when band-saws or power equipment are used or a few specific pathogens are suspected during a necropsy. Other biosafety sources have also recommended the use of eye and face protection for anticipated splashes/sprays when working with known or potentially infected animals (U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, and National Institutes of Health, 2007).

Survivability of *Salmonella* in aerosols and *Salmonella* transmission between animals via aerosols are well documented (Harbaugh et al., 2006; Oliveira et al., 2006; Wathes et al., 1988). There is likely a similar risk for airborne transmission of *Salmonella* from animals or the environment to humans. Kennel workers have been cautioned to take measures to reduce splashes of feces to the mouth when hosing or cleaning a kennel (CDC, 2001). While the potential is widely recognized, there do not appear to be any reports in the English language literature of *Salmonella* transmission to humans following aerosol or splash exposures (CDC, 2001). The difficulty of anticipating when or how such exposures will occur, might lead to a false perception of low risk and may explain infrequent use of adequate eye and face protection by many workers who come in contact with potentially infected animals or contaminated animal products. Furthermore, unanticipated circumstances in occupational settings may place workers at increased risk for transmission of zoonotic pathogens. In this case, an unanticipated malfunction of an overhead retractable hose prompted the pathologist to jump to reach the hose during the necropsy resulting in the splash exposure.

A motivating factor for ill persons to seek medical care and a diagnosis is illness severity. Clinical disease and illness severity are dependent on multiple factors including dose, strain virulence, and host factors. Clinical disease may be seen only infrequently following exposures and mild disease, if it occurs, is unlikely to be documented. In fact, among individuals who get exposed outside of the workplace, illness severity (bloody stool, duration ≥3 days) is the greatest predictor of seeking medical care and submitting a stool specimen for etiologic diagnosis (Scallan et al., 2006). In the described case, knowing the severity of disease in the adult cattle and that *Salmonella* had been isolated, led to concern about virulence properties of the infecting strain and further motivated the veterinary pathologist to seek medical care.

Multidrug-resistant strains of *Salmonella* have been shown to possess enhanced virulence in humans (Varma et al., 2005). In this case the strain of *Salmonella* Typhimurium isolated was susceptible to all of the antimicrobial drugs that were tested and did not appear to belong to any known subgroups with enhanced virulence. The multistate cluster, 0612MLJPX-1c, represented by a two-enzyme PFGE pattern was initially posted on PulseNet but did not merit further epidemiological investigation by CDC. This *Salmonella* Typhimurium subtype may be geographically widespread in cattle resulting in sporadic direct or indirect animal contact transmission to humans. Alternatively, *Salmonella* is a known and accepted contaminant of ground beef; transmission through food may also explain PFGE-matched cases from other states.

Exposure of the veterinary pathologist by contact with other *Salmonella*-contaminated fomites or even in other locations can not be completely ruled out. However, considering PFGE results, that the infecting strain lacked features that would suggest it had enhanced virulence, that high numbers of organisms may have been present in the bile fluids, and that others who handled *Salmonella* infected tissues did not become ill, we conclude that *Salmonella* transmission occurred through the documented splash exposure. This case highlights the importance of establishing and implementing a workplace infection control plan. In particular, measures to reduce aerosols and splashes and utilize suitable facial protection for workers should be reviewed.

**Acknowledgments**

The authors wish to thank Henrietta Hardin, Sheri Roberts, and Mike Sharp from Tennessee Department of Health Laboratory Services Section, and Nehal Patel from CDC PulseNet for...
their assistance. The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the Centers for Disease Control and Prevention.

References


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