Nontyphoidal *Salmonella*: An Occupational Hazard for Clinical Laboratory Workers

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Abstract

Laboratory-acquired infections due to nontyphoidal *Salmonella* are rare. Yet, recent outbreaks in microbiology teaching laboratories show that these species are still an appreciable occupational hazard for laboratory employees. This article presents two cases of nontyphoidal *Salmonella* that occurred at the authors’ institution—an infected patient and a clinical laboratory worker who acquired the infection by handling this patient's specimens.

Keywords

*Salmonella*; Clinical Laboratory; Occupational Hazards; AIDS; Opportunistic Infection; BSL-2

Case Report

Nontyphoidal *Salmonella* (NTS) is the most common bacterial cause of food-borne illness in the United States (Gould et al., 2013). While most symptomatic patients experience mild diarrhea, fever, and abdominal cramps, NTS infection is also the most common food-borne cause of hospitalization and death (Gould et al., 2013). This results in medical costs of $365 million annually (CDC, 2011) and necessitates collection of infectious specimens for clinical diagnostics. NTS is a biosafety level two (BSL-2) pathogen and an occupational hazard (U.S. DHHS, 2010).

Case 1

A 61-year-old male with a history of uncontrolled human immunodeficiency virus (HIV) presented in August with a 4-month history of non-bloody diarrhea. This diarrhea had become worse over the past 4 days, increasing to 10-15 bowel movements a day, accompanied by nausea, vomiting, night sweats, weakness, and syncope. The patient had poor medication adherence, and HIV serology completed a week before admission reported a CD4 count of 4 cells/μL and a viral load of 1,950,000 copies/mL. His only comorbidity was herpes simplex 2 infection. Home medications included valacyclovir (Valtrex), Triamcinolone-Acetonide cream, diphenoxylate-atropine (Lomotil), and HIV therapy (rilpivirine [Edurant] and elvitegravir-cobicistat-emtricitabine-tenofovir [Stribild]).

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During admission, the patient became septic (fever: 39.5°C, tachycardia: 123 beats/minute, tachypnea: 22 respirations/minute). Blood cultures were drawn, and he was started on vancomycin (Vancocin), meropenem (Merrem), and azithromycin (Zmax).

Pre-treatment blood cultures grew a Gram-negative rod after 11 hours of incubation, subsequently identified as *Salmonella enterica* serovar Enteritidis, susceptible to ampicillin, ceftriaxone, ciprofloxacin, and sulfamethoxazole-trimethoprim. The previous antibiotic regime was discontinued, and ceftriaxone (Rocephin) was started. On hospital-day one, a chest x-ray showed clear, underinflated lungs. Computed tomography (CT) scans of the head, chest, abdomen, and pelvis found no colonic thickening, lymphadenopathy, or effusions. One day later an esophagogastroduodenoscopy found erosive duodenopathy consistent with HIV enteropathy, a known cause of chronic diarrhea.

After beginning antibiotic treatment, the patient's symptoms improved and his bowel movements decreased to seven per day. For unknown reasons, he suddenly became septic again (fever: 39.3°C, tachycardia: 140 beats/minute, leukocytosis: 13,200 cells/μL) on hospital-day five. A chest x-ray (unchanged) and repeat blood cultures were taken. Antibiotic coverage was broadened to meropenem and vancomycin. Ceftriaxone was discontinued. The patient became afebrile, and his diarrhea improved slowly. He remained on meropenem and vancomycin for 2 days, until repeat blood cultures were negative for 48 hours, and he was discharged on oral levofloxacin (Levaquin).

At follow-up 5 days after discharge, the patient reported feeling “great,” with no fevers, chills, abdominal pain, nausea, or vomiting. His diarrhea had returned to baseline, manageable with diphenoxylate-atropine. He was motivated to adhere to continued HIV therapy, which should decrease HIV enteropathy-related chronic diarrhea.

**Case 2**

A previously healthy 45-year-old female employed as a clinical technician developed bloody diarrhea (4-5 bowel movements a day), abdominal cramps, and mild fatigue 4 days after working with *S. enterica* Enteritidis positive blood samples from Case 1. The employee's symptoms began 1 week after Case 1 was admitted to the hospital. The employee had no history of chronic disease, immunocompromise, or gastrointestinal conditions. Her only medication was daily fluticasone (Flonase).

The employee went to her primary clinic 5 days after developing symptoms. At this time a complete blood count was normal, and stool testing was negative for Cryptosporidium antigen, Giardia antigen, Clostridium difficile toxin, and Escherichia coli Shiga toxin. Her symptoms resolved over the next week without specific treatment, and she required no further medical care.

Because the employee had been involved with processing Case 1’s *S. enterica* Enteritidis positive blood samples, she sought additional stool testing on the sixth day after developing symptoms. Her stool culture grew *S. enterica* Enteritidis, and pulsed field gel electrophoresis was performed to compare her isolate with Case 1. The isolates were identical (Figure 1). Because *S. enterica* Enteritidis infection is commonly a food-borne illness, the health
department was alerted, and it investigated potential community sources. None of the employee's family members or friends became ill, despite sharing meals at home and restaurants during the week preceding her symptoms. Because of the isolated nature of the case and her occupational risks, the health department concluded that a laboratory source was most likely.

**Investigation**

While a known exposure has been reported in some cases of laboratory-transmitted NTS in the literature (mouth pipetting; 4), the exposure is often unknown (Blaser & Lofgren, 1981; Steckelberg et al., 1988). Similarly, in case 2, the point of exposure remains unclear. The affected employee has 20 years of experience in clinical microbiology and no previous laboratory-acquired illnesses. She consistently wears gloves in the laboratory and wore gloves to work with the *S. enterica* Enteritidis specimen from Case 1. Case 2's hand washing frequency on the day of exposure is unknown. In general, she washes her hands upon removing her gloves and before exiting the laboratory.

While the employee had contact with the patient's laboratory cultures, she was primarily supervising the laboratory work while training another technician in blood culture interpretation and processing. The affected worker was involved in only one processing step. She swabbed bacterial colonies from a culture plate, put the swab into a buffer, then shook the solution. Before the isolate was identified, these procedures were done outside of a biosafety cabinet. It is possible that droplets were splashed during this mixing action, which then contaminated the employee's glove. Given that the infectious dose of NTS can be as low as 1 cell in some instances (FDA, 2012), if even a small droplet subsequently got in the employee's mouth, this could have resulted in a clinically relevant infection. It is also possible that the employee was exposed through workspace contamination; however, no other laboratory workers, including the technician in training, experienced symptoms. Whether the other employees involved in processing Case 1’s samples wore gloves is unknown. In the laboratory, clinical technicians decontaminate their workspaces with Neutral Quat Disinfectant Cleaner (3M, St. Paul, MN) spray once daily after bench work is completed. They also decontaminate after visible spills or contamination occurs.

In recent Center for Disease Control (CDC) reported NTS laboratory outbreaks (CDC, 2012; CDC, 2014), having cell phones at the bench was a potential risk factor. While the employee does not remember her phone use on this day, she routinely brings her phone into the workspace, and thus it is another possible source of contamination. We did not culture phone surfaces for *Salmonella* species.

**Discussion**

The CDC has conducted surveillance on *Salmonella* since 1962, and historically, NTS accounts for less than 2% of laboratory-acquired infections (Pike, 1976; Wedum & Kruse, 1969). As a result, very few cases are reported in the literature. Despite this, two recent multistate *Salmonella* outbreaks in microbiology teaching laboratories show that proper knowledge and commitment to biosafety practices are essential to protect against this occupational hazard.
In both outbreaks, illness was most common among laboratory workers, microbiology students, and their children. In the first outbreak, August 2010 to June 2011, the CDC reports that 109 people were infected (CDC, 2012). Investigators traced the source to a commercially available *Salmonella enterica* serovar Typhimurium strain used in university microbiology laboratory courses. The second outbreak occurred from November 2013 to May 2014, during which time the CDC reports that 41 people were infected with *S. Typhimurium* (CDC, 2014). In this event, 71% of those affected were students in laboratory courses, and 14% were their instructors.

Other reports of NTS laboratory infections are rare. In two cases, from 1970 and 1988, students developed symptoms after exposure to *S. Typhimurium* in microbiology courses (Baumberg & Freeman, 1971; Steckelberg et al., 1988). In a third case report, from June 1980, the wife and 14-year-old son of a laboratory worker were co-infected with *Salmonella enterica* subspecies *enterica* serovar Typhi and multidrug-resistant *Salmonella enterica* serovar Agona (Blaser & Lofgren, 1981). The son was successfully treated, but the illness proved fatal for the employee’s wife.

Amidst the 2010 - 2011 *S. Typhimurium* outbreak, the CDC investigated laboratory biosafety practices. It found that biosafety training was not standardized nationwide and that enforcement of safety policies was variable. Indeed, employees at laboratories developing illness from *S. Typhimurium* were less knowledgeable about training materials than at laboratories that had not reported cases (CDC, 2012). Current national recommendations for working with NTS include: providing adequate biosafety training; increased hand-washing; restricting laboratory access; prohibiting eating, drinking, and smoking inside the laboratory; decontaminating surfaces after spills; using personal protective equipment (PPE); and reporting potential exposures (U.S. DHHS, 2010).

At the authors’ institution, these recommendations are generally well followed. All clinical laboratory technicians must maintain up-to-date biosafety training, and the availability of hand-washing sinks for use after working with infectious specimens is ample. Laboratory access is primarily restricted to those involved in specimen processing, and other persons (clinicians, students, trainees, etc.) must be accompanied by laboratory employees. Eating, drinking, and smoking do not occur in the laboratory, visible spills are decontaminated immediately, and gloves are routinely worn by most employees. As in other clinical laboratories, however, wearing gloves has not been universally adopted for all microbiological procedures. The U.S. Department of Labor’s Occupational Safety and Health Administration (OSHA) advises the use of gloves when handling potentially infectious material, including continued use when reading and subculturing plates (OSHA, 2011). Case 2 illustrates the additional possibility for transmission of infectious particles when making a suspension. Thus, the authors recommend that PPE always be used when making a suspension and gloves with visible droplets or spills be changed to prevent cross-contamination.

These cases highlight the need for microbiology laboratory workers to always be vigilant for possible exposures while working with pathogenic organisms, and to report any potentially infectious conditions promptly to employee health services and infection prevention.
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References


Figure 1.
Pulsed field gel electrophoresis results for Case 1 (patient) and Case 2 (laboratory employee). The isolates are identical.