Church Jetted Baptismal Font Linked to Legionellosis Outbreak—Tennessee, 2023

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Abstract

In May 2023, the Shelby County Health Department identified a legionellosis outbreak among attendees of the same church. Epidemiologic, environmental, and laboratory investigations were initiated. Laboratory-based surveillance identified persons with a positive *Legionella* test result. Church attendees were surveyed about attendance, symptoms of legionellosis, and water exposures. Environmental assessment of the church included asking about recent water management practices and collecting samples from water sources for culture. The health department identified 16 church attendees who had legionellosis symptoms. Of these, 9 (56%) had positive laboratory test results for *Legionella pneumophila*, 7 were hospitalized, and none died. Our investigation revealed that recent changes in water management practices at the church included renewed operation of a large, jetted baptismal font. In all, 17 environmental samples were collected; of these samples, 5 (including 4 from the baptismal font) had *L. pneumophila* serogroup 1 isolated by culture. Environmental sampling was crucial in identifying the baptismal font as the likely source of *L. pneumophila*. Education about water management and remediation recommendations were provided to staff at the church.

Keywords: *Legionella pneumophila*, legionellosis outbreak, serogroup 1, community education, water management

Introduction

Legionellosis is caused by *Legionella* bacteria and can present as Legionnaires' disease or Pontiac fever. Legionnaires' disease typically presents as pneumonia and frequently requires hospitalization. Pontiac fever is a milder illness characterized by symptoms of fever and muscle aches. Most *Legionella* infections in humans are caused by *Legionella pneumophila* serogroup 1 (Lp1). Transmission of *Legionella* occurs through inhaling aerosolized water droplets or aspirating water that contains the bacteria. In water systems, stagnation, warm temperatures, and sediment can facilitate *Legionella* growth and subsequent risk for legionellosis (Sciuto et al., 2021). Legionellosis outbreaks have been commonly associated with aerosolizing water sources such as showers, hot tubs, decorative fountains, and cooling towers (Centers for Disease Control and Prevention [CDC], n.d.).

Nationally and in Tennessee, legionellosis cases have increased during the past 2 decades to 3 cases per 100,000 population (Barskey et al., 2022; Tennessee Department of Health [TDH], n.d.). Shelby County includes Memphis and has a population estimated at 1 million individuals. In Shelby County, an average of 3 legionellosis cases a month have been identified during the past 10 years. In Tennessee, all positive test results for *Legionella* are reported to public health departments. After notification of a patient with positive test results for *Legionella*, health departments routinely collect information that includes chest radiograph results from medical records and interviews patients about symptoms, date of illness onset, and potential exposures (e.g., healthcare facilities, hotels, whirlpool spa).

In May 2023, the Shelby County Health Department (SCHD) initiated an outbreak investigation after identifying 3 people with Legionnaires' disease whose only common reported exposure was attending the same church during the 14 days before illness onset. To identify the *Legionella* source and prevent additional illnesses, SCHD and the Tennessee Department of Health (TDH) initiated epidemiologic, environmental, and laboratory investigations.

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Methods

Initial case ascertainment occurred through routine public health surveillance. After initiating the outbreak investigation, SCHD implemented an enhanced legionellosis survey questionnaire, which also included questions about attendance at places of worship, community events, retail shops, and grocery stores in subsequent interviews. SCHD officials also asked the Mississippi Department of Health for information about recent legionellosis illnesses among Mississippi residents because of that state border's proximity to the church and concurrent admission of Mississippi residents for legionellosis at the same hospital as the initial Tennessee cases.

An outbreak-specific survey was developed and administered among church attendees to facilitate finding cases and assessing exposure (Supplemental Survey, www.neha.org/jeh-supplementals). The survey included questions about demographic information and if the church participants had experienced symptoms (e.g., fever, muscle aches, cough, difficulty breathing) ≤14 days after having attended an event at the church.

If a participant reported symptoms, they were asked about healthcare facility visits and if they had either a chest radiograph or a test for legionellosis. Survey questions about church attendance included what day of the week they had attended a service, which events they attended, where they sat, and if they had used a bathroom. Additionally, church leadership invited their congregation to complete the online survey by email. The survey link was also posted on the church website and a telephone number for SCHD was provided for anyone who wanted to complete the survey by telephone. Survey data were collected and managed using REDCap (Research Electronic Data Capture) tools hosted at TDH (Harris et al., 2009, 2019).

The outbreak case definition was self-reported fever, muscle aches, or cough ≤14 days of attending the church in person between April 1 and April 30, 2023, which was before initial remediation measures. If laboratory confirmation of legionellosis was established (e.g., Lp1 was detected by urinary antigen testing), cases were classified as confirmed Legionnaires' disease; otherwise, they were classified as probable legionellosis. Individuals responding to the survey who did not have symptoms of legionellosis and who had attended the church after April 1 composed the control group. We used SAS version 9.4 to conduct chi-square (or Fisher's exact tests for cells with <5 observations) to compare frequency of exposures among cases and the control group.

SCHD and TDH officials conducted an onsite environmental assessment, where they asked staff about the source and management of water as well as the use, maintenance, and layout of the building. Next, 1 L of water was collected from locations identified as plausible sources of *Legionella* (e.g., kitchen, bathrooms, baptismal font) using 1-L bottles that contained sodium thiosulfate. Surfaces in contact with water were sampled using environmental sponge-stick swabs with a neutralizing buffer (3M). Water samples and swabs were stored and transported under refrigerated conditions (2–8 °C). An ExTab reagent was dissolved in an additional 20 ml of water from each source and total chlorine levels and water temperature were measured using a handheld meter (EXTECH EX900, Grainger Industrial Supply) with a minimum detection limit of 0.01 ppm. SCHD asked local health systems that were treating people with Legionnaires' disease to send clinical respiratory specimens to the TDH Division of Laboratory Services (TDH-DLS) for *Legionella* testing.

TDH-DLS tested for *Legionella* in all environmental samples via culture and tested water samples via real-time polymerase chain reaction (PCR) testing. Water samples were vacuum filter-concentrated through a 0.2-µm polycarbonate filter. The filter was then placed in 5 ml of sterile water and vortexed to free the bacteria and organic material. Next, 1 ml of the filtered sample was added to a sterile cryotube for *Legionella* PCR extraction, and 0.1 ml of the mixture was spread on buffered charcoal yeast extract and glycine-vancomycin-polymyxin-cycloheximide (BYCE-GVPC) agar plates (Remel, Thermo Fisher Scientific) for culture. For PCR testing, iQ-Check Legionella Real-Time PCR kits were used with the CFX96 Touch Real-Time PCR Detection System (Bio-Rad).

Suspect isolates of *Legionella* grown in culture were identified by matrix-assisted laser desorption/ionization (MALDI)–time of flight mass spectrometry (Bruker microflex used with RUO database version 4.3.18, Bruker Daltonics). *Legionella* serogroup was determined by latex agglutination. Isolates of *L. pneumophila* were sent to the Centers for Disease Control and Prevention (CDC) for further characterization. Isolates were first screened for genetic diversity by sequencing their *mompS* locus and determining the *mompS* allele numbers based on the European Society of Clinical Microbiology and Infectious Diseases Study Group for Legionella Infections (ESGLI) allele database. Although the database has not been publicly accessible since 2020, it is curated by UK Health Security Agency staff, and inquiries can be sent to legionella-sbt@ukhsa.gov.uk. A full (SBT)-based typing profile of seven *L. pneumophila* loci was generated for a subset of isolates (Lück et al., 2013).

This activity was reviewed and deemed not research by CDC and was conducted consistent with applicable federal law and CDC policy (45 C.F.R. § 46.102[l][2]; 21 C.F.R. § 56; 42 U.S. Code 241[d]; 5 U.S. Code § 552a; 44 U.S. Code § 3501 et seq.).

Results

Epidemiologic Investigation

From laboratory-based surveillance during April and May 2023, SCHD identified 14 individuals with Legionnaires' disease, of which 7 reported attending the same church ≤14 days before becoming ill. Additionally, one Mississippi resident had Legionnaires' disease after attending the same church.

The church had approximately 65 regular attendees weekly, and 35 attendees completed the survey, for a response rate of 54%. Among the 35 survey participants, 7 were the Tennessee residents who had already been identified through laboratory-based legionellosis surveillance. An additional 8 participants reported illnesses consistent with legionellosis, of which 1 reported positive *Legionella* testing. In total, we identified 16 cases from the church; 9 cases were confirmed Legionnaires' disease and 7 were probable cases of legionellosis. Illness onset dates for individuals with confirmed Legionnaires' disease and probable legionellosis occurred April 18–May 8 (Figure 1).

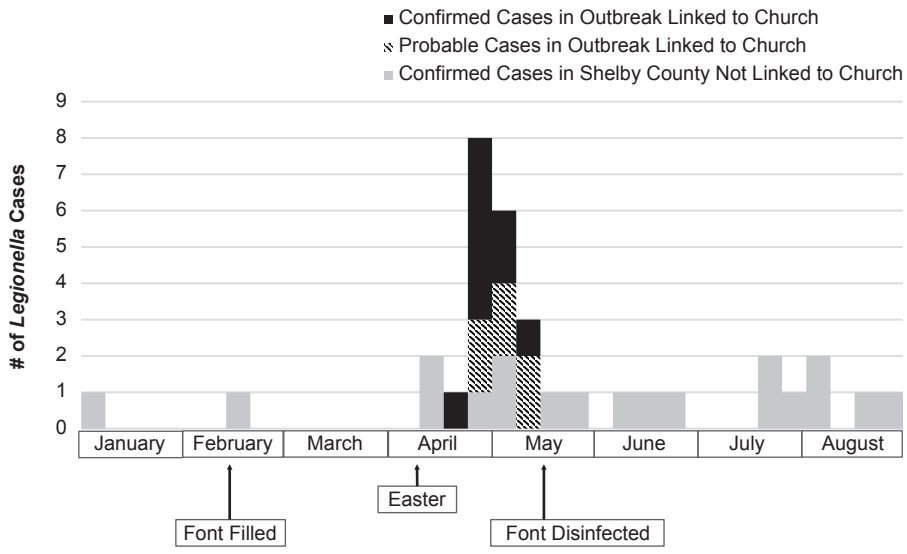
Among 16 confirmed and probable outbreak cases, 11 (69%) occurred in female individuals and 14 (88%) in people >50 years, consistent with church demographics. Most respondents (n = 14, 88%) denied having a smoking history and 2 (12%) reported having a former smoking history. As shown

in Table 1, most frequently reported symptoms were cough (*n* = 14, 88%); fever (*n* = 12, 75%); and fatigue (*n* = 11, 69%). All nine people with illness classified as confirmed Legionnaires' disease had abnormal chest radiograph results, eight had positive urinary antigen tests for Lp1 reported by healthcare facilities, and one reported testing positive for *L. pneumophila* in their survey response. This self-reported test result, however, could not be verified with a healthcare facility because the person lived in another state. No respondents had lower respiratory specimens cultured for *Legionella* bacteria. Of those affected, seven people with laboratory-confirmed Legionnaires' disease were hospitalized, and none died.

No statistically significant differences in frequency of auditorium seat location, weekday of church attendance, bathroom use, or kitchen use between survey responses for cases and the control group were reported (Table 2).

FIGURE **1**

***Legionella* Cases by Week of Illness Onset and Case Classification in Shelby County, Tennessee, January–August 2023**



Note. Exact onset date was missing for one probable case.

Environmental Assessment and Testing

Environmental assessment identified that the church was built during the 1980s and has an aging infrastructure. No water management program existed for identifying and flushing infrequently used water lines. Since implementing COVID-19 pandemic precautions in 2020, only the main portion of the building had been used by the church. This space included an auditorium with a capacity for approximately 250 people, a fellowship hall, a kitchen, and two sets of bathrooms.

The auditorium included a large, immersive, fiberglass baptismal font centered on the stage (Photo 1). The font held approximately 200 gallons of water that was filled using building plumbing connected to the city water system. The water was not chemically treated further. The water temperature was 88.4 °F, and the font had multiple submerged jets running continuously with a fast stream that resulted in bubbling at the water surface capable of producing an aerosol. Water in the font had been drained during the pandemic, and the font was refilled in February 2023. Prior to the pandemic, the baptismal font was always filled with water, with periodic draining, cleaning, and refilling. Since being refilled in February 2023, the water had not been changed, and sediment was visible. One church service in April 2023 had included a baptism; none of the ill people had been baptized at that time.

One set of bathrooms with multiple stalls and sinks was off the main hall and accessible to all attendees. The other set of bathrooms, which each included a single sink and toilet, was in a hall behind the auditorium's front stage and accessible only to church staff and people being baptized. The kitchen included two sinks and an ice machine. Drinking fountains in the church were covered with plastic bags and had not been used since before COVID-19 pandemic restrictions were implemented in 2020. The heating, ventilation, and air conditioning (HVAC) system had not been used that season. The church grounds did not include an irrigation system or water feature.

Environmental testing focused on the areas that had been visited by people with legionellosis and frequented by the congregation. Health department staff swabbed nine surfaces in contact with water: two from the ice machine and drain, one from a kitchen sink faucet, two from sinks in the set of bathrooms off the main hall, one from a surface in the men's bathroom behind the stage, and three from the baptismal font. An additional eight water samples were collected that included two from the kitchen sinks, two from sinks in the set of bathrooms off the main hall, two from sinks in the set of bathrooms behind the auditorium front stage, one from the baptismal font, and one from the water heater.

Chlorine levels were undetectable in all eight water samples. *Legionella* DNA was detected by real-time PCR testing from three water samples taken from the baptismal font and both faucets from the set of bathrooms behind the auditorium front stage. Lp1 was isolated by culture from three swabbed specimens, one water sample from the baptismal font, and one water sample from the women's bathroom sink behind the auditorium front stage. Full sequence-based typing (SBT) of two isolates from the baptismal font and women's bathroom revealed a novel allelic profile (2-3-18-15-5-1-20) compared with sequence types in the ESGLI database. This profile was given the designation ST3250. The remaining three isolates were assessed at only a single SBT locus, *mompS*. These three isolates shared the same *mompS* allele (mompS5) as the fully typed isolates.

TABLE **1**

Patient Characteristics by Outbreak Case Status, Shelby County, Tennessee, 2023

Characteristic	Confirmed Cases (*n* = 9) # (%)	Probable Cases * (*n* = 7) # (%)	Total Cases (*N* = 16) # (%)
State of residence			
Tennessee	7 (78)	6 (86)	13 (81)
Mississippi	2 (22)	1 (14)	3 (3)
Median age (range; years)	67 (56–80)	67 (20–75)	67 (20–80)
Sex			
Female	6 (67)	5 (71)	11 (69)
Male	3 (33)	2 (29)	5 (31)
Smoking status			
Never a smoker	8 (89)	6 (86)	14 (88)
Former smoker	1 (11)	1 (14)	2 (13)
Symptoms			
Cough	8 (89)	6 (86)	14 (88)
Fever	8 (89)	4 (57)	12 (75)
Fatigue	7 (78)	4 (57)	11 (69)
Shortness of breath	6 (67)	3 (43)	9 (56)
Chills or rigors	5 (56)	4 (57)	9 (56)
Muscle aches	4 (44)	4 (57)	8 (50)
Loss of appetite	3 (33)	4 (57)	7 (44)
Headache	3 (33)	4 (57)	7 (44)
Diarrhea	3 (33)	3 (43)	6 (38)
Abdominal pain	2 (22)	3 (43)	5 (31)
Visited healthcare facility	9 (100)	5 (71)	14 (88)
Hospitalized	7 (78)	0	7 (44)
Chest radiograph findings			
Abnormal	9 (100)	0	9 (56)
Normal	0	2 (29)	2 (13)
Not done	0	3 (43)	3 (19)
Unknown	0	2 (29)	2 (13)
Legionellosis testing			
Positive test result	9 (100)	0	9 (56)
Negative test result	0	1 (14)	1 (6)
Test not done	0	3 (43)	3 (19)
Test status unknown	0	3 (43)	3 (19)

* Survey data were missing information about all symptoms except cough and abdominal pain for one probable case and age for another probable case.

Public Health Response

During this outbreak response, public health guidance was updated based on environmental testing results to facilitate congregational safety when meeting. After initially identifying the outbreak and detecting *Legionella* in water samples, the congregation did not use the auditorium, baptismal font, or auditorium bathrooms until the baptismal font was cleaned and disinfected and the entire church water system flushed. Repeat environmental testing approximately 1 week after the church had resumed services detected *Legionella* DNA from the men's bathroom by real-time PCR behind the auditorium but did not isolate *Legionella* by culture. Environmental testing 2 months later, however, again identified the same Lp1 (ST3250) from the baptismal font via sequence-based typing. Because of the risk associated with exposure to *Legionella*, public health officials issued a health directive closing the baptismal font and the auditorium bathrooms until the church hired an outside firm to complete remediation.

Discussion

We identified a legionellosis outbreak with 16 cases associated with a local church. Growth of Lp1 (the serogroup detected by urinary antigen testing) from the baptismal font, coupled with the temporality of congregational exposure after filling and operation of the font, support the baptismal font as the primary source of exposure. Although Lp1 was isolated also from the women's restroom behind the auditorium, we did not attribute illnesses to this location because the restroom was minimally used. Established partnerships among TDH, SCHD, TDH-DLS, and CDC facilitated the appropriate environmental testing and subsequent identification of a novel *L. pneumophila* sequence type.

Temporary building closures that were implemented during the COVID-19 pandemic might have created conditions that promoted the growth and proliferation of *Legionella* in stagnant water systems, although the association of building closures and *Legionella* growth remains unclear in the literature (Dowdell et al., 2023; Liang et al., 2021). The jetted baptismal font was filled for the first time in February 2023 since the beginning of the pandemic in 2020. Water in the church water system that supplied the baptismal font was probably colonized, with further bacterial replication possibly occurring during water stagnation (i.e., while the font was unused for at least 2 years). Because building reopenings might present opportunities for increased spread of *Legionella*, assessment of trends and changes in facility

Photo 1. Large, jetted baptismal font in church auditorium, Shelby County, Tennessee, 2023. Photo courtesy of the Shelby County Health Department.

water use is essential during investigations of community legionellosis clusters.

Churches and other faith-based buildings are uncommon sources of legionellosis outbreaks. Church staff were unaware that water in the building could harbor pathogens such as *Legionella*, and the church did not have a water management program, which is similar to many other facilities that have been implicated in Legionnaires' disease outbreaks (Clopper et al., 2021).

We discerned a need to increase our trustworthiness with church leaders, who shared concerns about detrimental consequences to church attendance from public health responses. They feared that this outbreak, occurring shortly after stay-at-home orders related to the COVID-19 pandemic, might result in the church closing. Public health personnel strove to build trust through frequent and transparent communication, which included sharing tailored educational resources (CDC, 2016, 2024a; TDH, 2019), laboratory test results, and next steps as information became available. We also strove to honor the church's priorities during the response (e.g., allowing services to continue in a different location, identifying firms that could quickly complete remediation).

During this investigation, we also identified that facilities such as churches with limited resources might experience financial and logistical barriers to implementing water management programs compared with well-resourced facilities. For example, churches do not have the professional guidance that healthcare facilities do, which have guidelines from professional societies such as ASHRAE (n.d.).

Moreover, professional guidelines specifically adapted for water management in community settings with limited resources might have benefited this outbreak response by providing recommendations that were more suited to church facilities, including the jetted baptismal font. We initially developed specific flushing guidance and a water management program for the church with the assistance of the local utility provider.

Although the church implemented this guidance, repeated environmental testing identified Lp1 bacteria 2 months after initial testing, which required the church to hire a remediation firm. Thus, public health partnerships with engineering and plumbing specialists to adapt water system maintenance guidance for buildings operated by resource-limited organizations could help prevent *Legionella* outbreaks in community settings and avoid costly remediation efforts.

TABLE **2**

Comparison of Church Exposures Among Survey Respondents by Outbreak Case Status, Shelby County, Tennessee, 2023

	Confirmed and Probable Cases * (*n* = 15) # (%)	Control Group Responses (*n* = 20) # (%)	*OR* and 95% Confidence Interval
Day attends church **			
Sunday	14 (93)	20 (100)	0.76 [0.02, 31.12]
Wednesday	7 (47)	10 (50)	0.88 [0.23, 3.34]
Tuesday Bible Class	2 (13)	7 (35)	0.29 [0.03, 1.97]
Seat location			
Sits in back	5 (33)	15 (75)	Reference
Sits in front	6 (40)	5 (25)	3.60 [0.59, 22.50]
Missing or unknown	4 (27)	0 (0)	Excluded
At pulpit during service	1 (7)	4 (20)	0.34 [0.01, 4.24]
Events **			
Easter	9 (60)	17 (85)	0.79 [0.08, 11.24]
Gospel	11 (73)	18 (90)	0.61 [0.04, 9.71]
Baptism	6 (40)	11 (55)	0.82 [0.20, 3.43]
Used any church bathroom **	7 (47)	14 (70)	0.75 [0.12, 4.92]
Main bathroom	7 (100)	11 (79)	4.57 [0.21, 101.60]
Auditorium bathroom	0 (0)	1 (7)	1.94 [0.05, 83.19]

* One ill person did not respond to the survey.

** Survey respondents could indicate multiple exposures within these categories. *OR*s were calculated by comparing responses from respondents who indicated an exposure with respondents who did not indicate an exposure.

Limitations

A major limitation of our investigation was that clinical *Legionella* respiratory cultures were not conducted for any patient in this outbreak, which meant we could not compare genetic profiles of clinical Lp1 isolates with environmental isolates. Guidance for severe community-acquired pneumonia recommends testing for *Legionella* urinary antigen and *Legionella* culture (Metlay et al., 2019). Although culture remains the gold standard diagnostic test for *Legionella*, isolating the bacteria can be difficult because of prior antibiotic treatment and specific laboratory

requirements such as the use of buffered charcoal yeast extract (BCYE) medium and skilled technologists (Bai et al., 2023). Furthermore, widespread availability and ease of *Legionella* urinary antigen testing might dissuade clinicians from obtaining lower respiratory specimens for *Legionella* culture, which is useful in public health investigations to link clinical illnesses with environmental sources.

In addition to the lack of lower respiratory specimens, our work was limited in that the survey was predominantly offered online, which might have resulted in participation bias based on church attendee comfort and willingness to navigate the online platform. Additionally, underdetection of probable cases might have occurred if legionellosis symptoms were mild and self-limiting. The limited number of survey responses might also have resulted in underdetection of probable cases or the inability to identify a difference in exposures in the epidemiologic investigation (such as seat location) between church attendees who did and did not become ill. Alternatively, overdetection of probable cases could have occurred because symptoms included in the case definition were not specific to legionellosis only.

Conclusion

In this legionellosis outbreak, environmental sampling in a church identified the likely *L. pneumophila* source as the immersive jetted baptismal font. Water stagnation in church plumbing during closures related to the COVID-19 pandemic might have increased *Legionella* risk when the baptismal font was refilled. Increased awareness of legionellosis risks and the importance of water management—including when reopening buildings (CDC, 2024b)—is needed among faith-based organizations. Collaboration with engineering and plumbing specialists is needed because public health agencies can be limited in providing expertise and resources for mitigating legionellosis risk in facility water systems in uncommon outbreak settings.

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Did You Know?

The Private Water Network is a virtual platform and community of professionals working to protect the public's health from contaminants in private drinking water sources. Learn more and join today at www.neha.org/private-water-network.