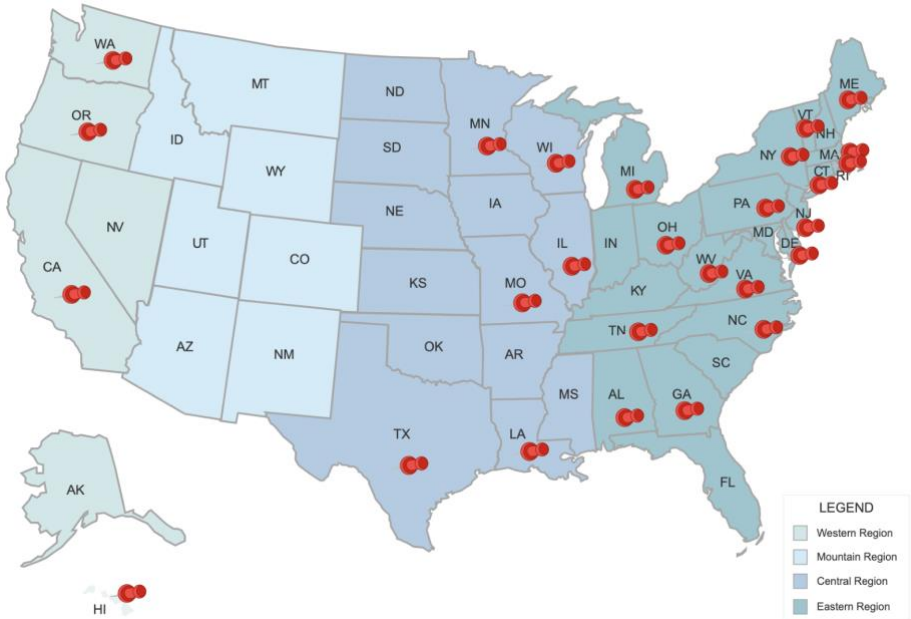


Feedback from operational stakeholders who manage or respond to outbreaks is that they are often too busy to review literature or obtain relevant background information to assist them with acute response. Unlike a traditional analytical outbreak investigation report, **Watching Briefs** are intended as a rapid resource for public health or other first responders in the field on topical, serious or current outbreaks, and provide a digest of relevant information including key features of an outbreak, comparison with past outbreaks and a literature review. They can be completed by responders to an outbreak, or by anyone interested in or following an outbreak using public or open source data, including news reports.

Watching brief	
Title	Decreased Legionnaires' disease incidence in the United States during the COVID-19 pandemic, 2020-2022
Authors	Devarajulu Reddy, Diviya Alex, Christina Zonunmawii, Sabarish Prabhu, and D.N. Dhillan
Date of first report of the outbreak	19-09-2020 (1)
Disease or outbreak	Legionnaires' disease
Origin (country, city, region)	Multistate, USA (Refer to Figure 1 below for a full list of affected states) (1–5).
Suspected Source (specify food source, zoonotic or human origin or other)	Contaminated water supply with <i>Legionella Spp.</i> (6).
Date of outbreak beginning	September 2020 (7).
Date outbreak declared over	Ongoing as of 25 October 2022.

Affected countries & regions	States reporting confirmed cases of Legionnaire's disease during the study period of September 202- October 2022 (Figure 1), include: Virginia, Ohio, Wisconsin, Michigan, Illinois, Georgia, Oregon, Minnesota, North Carolina, New Jersey, New York, Washington, Pennsylvania, California, Vermont, Tennessee, Delaware, Maine, Texas, Hawaii, Massachusetts, Louisiana, Alabama, Rhode Island, West Virginia, Missouri, Connecticut (1–5).  Figure 1. States marked with red reported confirmed cases of Legionnaire's disease between September 2020 and October 2022 (1–5).
Number of cases (specify at what date if ongoing)	Due to the lack of formal reporting the total number of legionnaires cases during September-2020-October-2022 is unclear. However, approximately 491 cases were identified via EPIWATCH, during the same period (1-5).
Clinical features	Legionnaires' disease has an incubation period ranging from 2-14 days. Clinical features include (8): • Fever ▪ Shortness of breath ▪ Headaches ▪ Myalgia ▪ Gastrointestinal symptoms such as nausea, abdominal pain, or diarrhea ▪ Failure to respond to beta-lactam antibiotics Physical examination: ▪ Rales sounds on examination of the lungs, and signs of lung consolidation with non-specific radiographic features Laboratory investigations: ▪ Hyponatremia ▪ Elevated liver enzymes ▪ CRP levels >100 mg/L

Mode of transmission (dominant mode and other documented modes)	Transmission of <i>Legionella spp</i> , the bacteria that causes Legionnaires' disease, is via inhalation of aerosols containing the bacteria, which then travel into the lungs resulting in infection (9). Human-to-human transmission is very rare, with only one possible case reported (4). This case was in Porto, Portugal, after an employee at an industrial cooling tower was infected with Legionnaires' disease (10). His mother subsequently became sick with Legionnaires' after caring for her son in a small nonventilated room in their home. Samples taken from the house were negative for Legionnaires' (10).
Demographics of cases	Cases are generally distributed among the elderly population often seen in 50 – 60 year old people, and among individuals with weakened immune systems, smokers, and people with respiratory infections (9). The presence of cases is usually associated with an area or facility that has a large water tank or water reservoir (for example, a fountain) or expansive plumbing system, including in healthcare facilities and cooling towers (9).
Case fatality rate	The case fatality rate (CFR) for Legionnaire's disease is 5-10% and in immunocompromised individuals is around 40–80% (11).
Complications	Legionnaires' disease diagnosis is complicated, as the disease presentation is similar to other diseases such as influenza and other types of bacterial pneumonia, which can delay appropriate testing (12). There are specific diagnostic tests required for a Legionnaires' diagnosis, including sputum culture and urine samples, however given these are not routine tests for laboratories, they need to be requested by the treating clinician. Environmental sampling to identify a source is also often a component of Legionnaires' outbreak investigation (12). Legionnaires' disease may lead to ongoing complications, including: • Respiratory failure • Septic shock • Acute kidney and multi-organ failure (11,13).
Available prevention	There is no vaccine available for Legionnaires' disease, and prior infection does not prevent reinfection (14). However, individuals with confirmed/suspected Legionnaires' disease do not require isolation or contact precautions as human-to-human transmission is very rare (10). The primary method of prevention is based upon controlling for <i>Legionella spp</i>. contamination in water distribution systems (10). Water-based prevention methods include copper-silver ionization, hyper-chlorination, thermal shock, chlorine dioxide, monochloramine, and point-of-use filters in water sources (15,16). Appropriate water management maintenance methods are commonly employed in numerous infrastructures and industries, including hotels, cooling towers and healthcare facilities, to reduce risk (17). Water maintenance is important for numerous water systems including hot tubs and decorative fountains, and this includes doing routine water sampling for Legionella.

	Whenever there is an increase in buildup on shower heads and faucet screens, these should be cleaned and replaced. Furthermore, water heater settings should be maintained at least 120 degrees (17).
Available treatment	The empiric treatment for community-acquired pneumonia due to Legionnaires' disease is antibiotics, namely from the fluoroquinolone group which are broad spectrum antibiotics (such as levofloxacin) or a medication from the macrolide group (such as azithromycin) (20). If mild pneumonia is observed, then Azithromycin 500 mg orally once daily or Levofloxacin 750 mg orally once daily is recommended (20). If moderate or severe pneumonia is observed in patients, Azithromycin 500 mg IV or orally once daily or Levofloxacin 750 mg IV or orally once daily is recommended (20). Individuals who are immunocompromised are at higher risk of contracting disease and should be especially careful (19).
Comparison with past outbreaks	The number of cases reported to the Centre for Disease Control (CDC) has been on the rise since 2000 (21), likely due to expanded diagnostic testing and public awareness of symptoms. In the US, an average of 1,221 cases were reported annually during 1992-2002 and an average of 4,369 cases were reported annually during 2013 -2018, with a total of 8,890 cases reported in 2019 (22,23). Age standardized average incidence among men increased from 0.63/100,000 population to 1.80/100,00 population (23). The age standardized average incidence was less in white Caucasian persons compared to African American persons. The Age standardized average was high in the Northeast and Midwest compared to the south and west geographic area. The overall incidence is high during the June to November months which are the summer months in the USA, a time period where Legionnaires' disease is often more frequent due to increased temperature and swimming (23). The EPIWATCH surveillance system, using open-source data, reported approximately 28 cases during September to December 2020, 349 cases in 2021 and 114 cases during January to October 2022, which is a decrease in case numbers (1-5). There is a lack of available case data reported by the CDC for this period and underreporting has likely occurred due to the ongoing COVID-19 pandemic. Annual case numbers may be 1.8 to 2.7 times higher than reported, due to potential underdiagnosis and the requirement for confirmation of infection source before a diagnosis can be made (24).

Unusual features	In addition to the issues regarding underreporting, Legionnaires' disease is frequently underdiagnosed given the specific diagnostic testing required and mimicking of other respiratory diseases (24). Socioeconomic factors have also been found to be associated with increased incidence of infection, with higher incidence in lower socioeconomic areas (25). This is reflected in the finding that the age standardized average incidence of the disease is less in white Caucasian persons compared to African American persons (23). Health disparities in the United States are often linked to lower socioeconomic status and are more pronounced among racial and ethnic minority populations compared to white populations (26).
Critical analysis	The underreporting seen over the past 3 years alongside the COVID-19 pandemic may be attributed to numerous reasons. Firstly, the pandemic saw restrictions in public health capacity and the ability of teams to respond appropriately to manage COVID-19, which presumably had negative implications for the surveillance of other diseases. Testing and diagnostic capacity for Legionnaires' may have also been reduced given COVID-19 testing was prioritized for respiratory infections (27). Accompanying a lack of reporting is likely a reduced rate of incidence, given people spent more time at home due to lockdowns and restrictions, therefore reducing their exposure to possible sources of infection. Strong surveillance programs are crucial to understand the trajectory of transmission and health outcomes (28). Adequate surveillance allows for early identification of outbreaks, outbreak monitoring, investigation into possible source, and implementation of preventive measures (24). There is the possibility that there are missed cases and that some transmission could have been prevented due to the reporting issues (24). Legionnaires' disease surveillance can compound the challenges associated with health disparities. Surveillance for Legionnaires' disease is crucial for early detection and prevention, but several factors can make it difficult to track and manage effectively, including: the complicated diagnosis process, underdiagnosis and migration of those infected from the source (24). Prior to 2020, the increase in incidence was likely due to, 1. Increase in the aged population 2. Increase in disease awareness 3. Regular surveillance and reporting systems 4. Building infrastructures, designs, and maintenance weather patterns 5. Lack of adequate maintenance of water systems, particularly complex water plumbing systems or water reservoirs (9). As health system capacity stabilises after the impact of the COVID-19 pandemic, and living and working circumstances return to pre-pandemic norms, the same reasons driving the increase in infections up until 2019 may lead to a resurgence of legionella infections in the coming years.

	The Centers for Disease Control and Prevention (CDC) monitors cases of Legionnaires' disease through various surveillance systems, including the National Notifiable Disease Surveillance System (NNDSS) and the Supplemental Legionnaires Disease Surveillance System (SLDSS) (29). Public health officials should report outbreaks of Legionnaires' disease and Pontiac fever through the Waterborne Disease Outbreak Surveillance System (WBDOS) of the National Outbreak Reporting System (NORS) (29). It is crucial that these organizations remain funded to monitor the surveillance of Legionnaires' disease outbreaks and should continue to accelerate new surveillance systems to effectively track and trace outbreaks while improving reporting.
Key questions	1. How will the limited reporting over 2020-2022 impact monitoring of outbreaks in 2023 and 2024? 2. How can surveillance of Legionnaires' be strengthened globally? 3. Will the experience of COVID-19 and awareness of infection control strategies on an individual level continue and drive an ongoing decrease in Legionnaires cases? 4. How can knowledge and practice about Legionnaires improve the decline of the incidence of Legionnaires? 5. How frequently should environmental surveillance for Legionnaires in air or water samples by the Environmental Health and Safety (EHS) professionals be conducted? 6. What measures should be introduced by the CDC (NNDSS / SLDSS) to strengthen the Legionnaires surveillance to overcome the under diagnosis and under-reporting?
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