WATER-RELATED DISEASES

Closer scrutiny needed to manage outbreaks of Legionnaires' disease in SA water systems

Researchers have found significant levels of Legionella bacteria in both inner city and rural water distribution systems in South Africa, emphasising the need for better monitoring, management and maintenance of these systems. Tony Carnie reports.

Legionnaires' disease is a severe form of pneumonia caused by the contamination of water with ***Legionella*** bacteria. These bacteria are ubiquitous in nature and can also spread and settle in treated drinking water systems – especially in large buildings or when distribution systems are old or poorly maintained.

The disease was only discovered following the first known outbreak in 1976. It started in a high-rise hotel in the United States during a convention of American Legion military veterans – hence the name Legionnaires' disease. Despite prior chemical treatment and the high water temperatures in geysers, these opportunistic pathogens can survive stressful conditions in water distribution systems and cause ***Legionellosis*** (also known as Pontiac fever or Legionnaires' disease).

Symptoms include a severe headache, fever, chills, chest pains and dry cough, and can be fatal – especially in vulnerable populations. Older people and those with compromised immune systems, including people with HIV and tuberculosis, are at increased risk of infection, with only 5% of healthy individuals likely to develop the disease. In Europe, the number of cases of ***Legionellosis*** reported in 2017 shows an incidence rate of between 1.8 and 2.2 per 100 000 people.

Previous studies in South Africa suggest that reported cases of Legionnaires' disease in South Africa are relatively low compared to other waterborne diseases, such as cholera and typhoid fever. For example, 12 cases were found at a Johannesburg teaching hospital during 1985 and another 93 cases were reported between 2018 and 2020, mostly in older men in hospitals in the Western Cape. More recent data have shown that the Western Cape reported the most cases of ***Legionellosis*** (20 cases) from March to August 2023. This was followed by Gauteng province with five cases in 2023.

Globally, the threat from Legionnaires' disease is compounded

because its victims tend to show the same symptoms as patients infected with the Covid-19 coronavirus, including cough, chills, and fever - making misdiagnosis a possibility.

A new research project funded by the Water Research Commission (WRC) cautions that the incidence of Legionnaires' disease in South Africa may be underreported due to diagnostic limitations or misdiagnosis, with many cases possibly obscured by similar symptoms to other respiratory illnesses, such as pneumonia. Due to increasing urbanisation, aging infrastructure, and climate change, the public health threat posed by ***Legionella*** is also expected to rise, the report warns.

It further notes that South Africa is faced with the dual epidemics of HIV and TB, as well as resource and medical care limitations. "This heavy burden of disease creates both a diagnosis bias, hiding many other diseases, and an immunocompromised population susceptible to many other diseases. This might explain the lower rate of reported ***Legionellosis*** cases in South Africa in comparison to developed countries."

The research team, hailing from four universities (Johannesburg, Venda, United Arab Emirates and Zimbabwe), collected and analysed water samples from a variety of urban and rural areas, including Hillbrow in Johannesburg, Atteridgeville township in Pretoria, rural settlements around Thohoyandou in Vhembe province and from the Zandspruit and Melusi informal settlements in Gauteng.

Notably, the híghest levels of ***Legionella pneumophila*** contamination were found in Hillbrow. Though the majority of tenants interviewed in the study had access to building geysers, many did not use them, opting for cold baths or boiling their own water. The researchers found that ***Legionella*** was highly prevalent in Hillbrow, particularly in cold tap water and geysers. Cold tap water showed moderate contamination, with several samples in the 11–100 MPN/100 mℓ range, while one building

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Project leader, Dr Atheesha Singh, says Legionella *bacteria pose a public health risk in both urban and rural areas, particularly where water systems are poorly maintained or where conditions favour bacterial growth.*

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The position of water storage tanks on the roof can impact water quality as there is no shade and the warmer temperature promotes microbial growth.

sample exceeded 1000 MPN (Most Probable Number), indicating severe contamination.

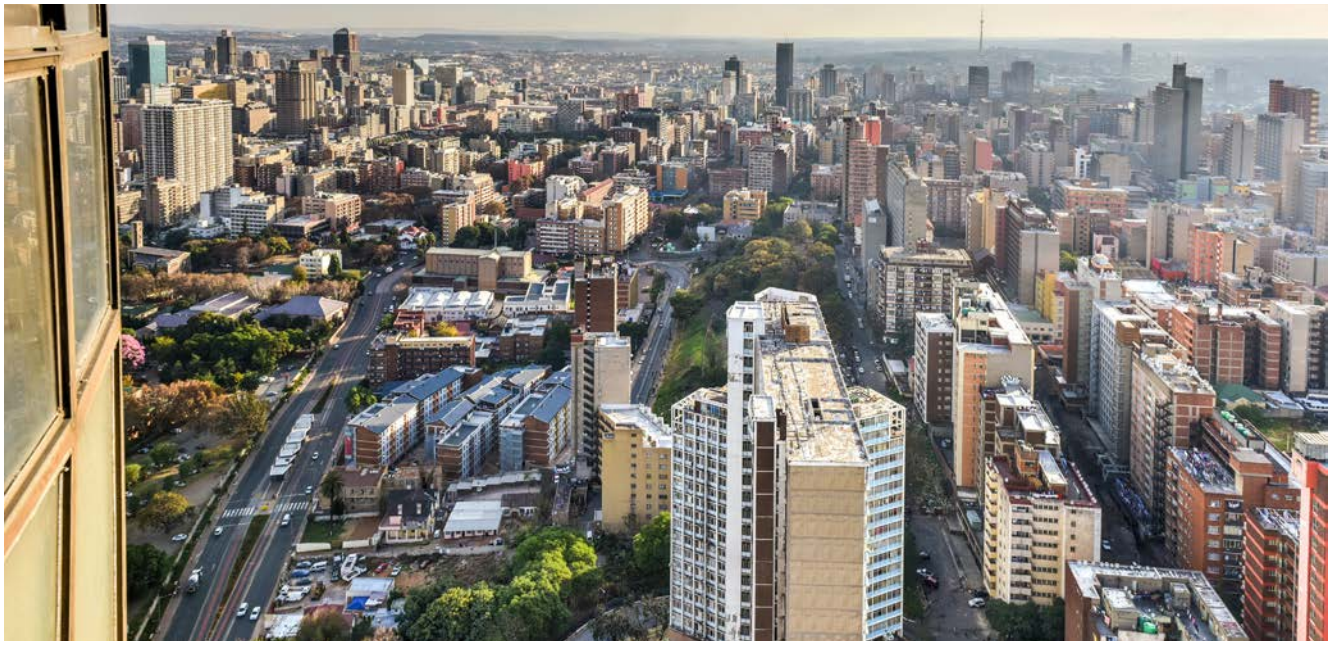
Geyser water in Hillbrow showed lower contamination, with 13 samples in the 11–100 MPN range. Biofilm samples from taps and showerheads also showed contamination, pointing to potential challenges in maintaining safe water distribution systems in dense urban environments.

The researchers note that Hillbrow is one of the most densely populated metropolitan areas in Southern Africa, with limited records of plumbing renovations and maintenance. It has been estimated that there are nearly 75 000 people living here within just one square kilometre. With so many people cramped together (some in living rooms, small bedrooms or kitchens), this can impact personal hygiene, while the density of ageing piping in multiple-floor buildings can promote microbial growth.

In Vhembe, a rural area in Limpopo province, the study found considerable ***Legionella*** contamination, mainly in stored water and geysers, with several samples exceeding acceptable safety limits. In Vhembe, cold tap water contamination was minimal, with most samples below 1 MPN, but two samples fell into the 11–100 MPN range, and one sample exceeded 2272.6 MPN. Contamination was especially prominent in informal housing structures where storage tanks were not regularly maintained, allowing ***Legionella*** to thrive.

In Atteridgeville, contamination levels were moderate, at levels generally below those in Hillbrow and Vhembe. However, one cold water sample in Atteridgeville was above 2272.6 MPN/100mℓ. Geyser water was mostly uncontaminated and stored water followed similar trends, with most samples showing low microbial counts. However, biofilm samples from infrequently used taps and showerheads still showed contamination risks.

The informal settlements of Zandspruit and Melusi had relatively



In densely populated urban areas, maintaining a consistent water temperature and ensuring adequate chlorination throughout the entire water system can be challenging. This is partly because of potential temperature differences while pumping water in older high-rise buildings.

lower levels of contamination. Although most of the samples from these areas fell within acceptable limits, a few exceeded the threshold, particularly in older storage systems and shared community taps.

In Zandspruit, microbial contamination was more pronounced, with 18 cold tap water samples in the 11–100 MPN range and one sample in the 101–1000 MPN range. In Melusi, microbial contamination was lower but still present, with seven cold tap water samples in the 11–100 MPN range. These results indicate that even in areas with lower population density, inadequate infrastructure and sporadic maintenance poses significant risks for ***Legionella*** growth.

Risk assessments suggest that contamination in these areas is driven by a combination of factors, including older infrastructure, biofilm formation, inadequate maintenance, and environmental conditions that promote ***Legionella*** growth. "This underscores the need for regular monitoring, system upgrades, and community-level education to mitigate the public health risks associated with ***Legionella***-contaminated water," the study notes.

Project leader, Dr Atheesha Singh, explained that ***Legionella*** often proliferate due to the gradual build-up of biofilms (hard or slimy layers of bacteria and fungi that form on the inner surfaces of water tanks and pipes, particularly in areas with mineral deposits or rough surfaces). Once established, biofilms become difficult to eliminate.

Singh, a microbiologist and senior lecturer at the University of Johannesburg's Water and Health Research Centre, said: "One of the most important lessons from our research is that managing water systems to reduce ***Legionella*** and biofilm growth requires a proactive, system-wide approach. It starts with the materials used in the plumbing systems. Certain plastics and ageing metals can support microbial growth or corrode over time, thereby creating rough surfaces that promote biofilm formation.

"In contrast, plumbing materials like copper pipes have been shown to inhibit bacteria . . . Thus, choosing the right materials at the design and construction phase of a water system can make a lasting difference in water safety."

Unfortunately, retrofitting water infrastructure in existing buildings is not always possible. However, she says that there are still practical methods to reduce the risks significantly – including regular maintenance. "Dead legs in plumbing systems (disused sections of pipe where water does not circulate) create ideal conditions for stagnation and microbial proliferation. Routine water system assessments are necessary to identify and eliminate these zones and to ensure consistent water flow throughout a building.

Temperature control also plays a key role. "Where feasible, hot water systems should be maintained at temperatures above 55°C, as ***Legionella*** is less likely to survive at higher temperatures."

This, however, must be carefully balanced with energy efficiency goals and the risk of scalding, particularly in residential areas.

Singh notes that chemical disinfectants, such as chlorine bleach, are widely used, but ***Legionella*** can still survive within protective biofilms, making them less susceptible to chemical treatment. A more effective strategy involves combining chemical disinfection with physical interventions, such as regularly flushing unused outlets, descaling tanks and pipework, and implementing a site-specific water safety plan.

At the household level, residents who rely on storage containers (such as buckets or JoJo tanks) should clean them regularly by using hot water and detergent to reduce microbial contamination. Taps and showers that are rarely used should be

flushed out frequently.

Singh also recommends that monitoring and controlling ***Legionella*** should begin with routine environmental surveillance, especially in densely populated residential buildings with complex plumbing. "Water sampling should be conducted periodically, approximately every three to six months. Samples should be taken from hot water systems, storage tanks, and outlets that are seldom used, as these locations are prone to stagnation and biofilm formation."

These samples can be tested for ***Legionella*** using culture-based methods, which remain the gold standard for detecting viable bacteria.

"Where resources allow, molecular techniques such as polymerase chain reaction (PCR) offer quicker results and greater sensitivity. Screening tools like Legiolert® are being adopted for initial testing, as they are user-friendly, cost-effective, and capable of detecting ***Legionella pneumophila***, the species most commonly associated with disease, within seven days."

However, the choice of testing method and whether testing is done at all often depends on the availability of laboratory capacity and the feasibility of implementation. "In the South African context, microbiological testing is typically outsourced to accredited water laboratories, as most building facilities lack in-house capacity."

All actions should be guided by a Water Safety Plan with clear roles for building managers or caretakers. "Managing ***Legionella*** requires ongoing vigilance, not just during outbreaks, but as part of routine building maintenance and public health protection," she stresses.

While water utilities are responsible for delivering microbiologically safe water up to the point of distribution, residential property owners and occupants also have a critical role to play, especially where water is stored in tanks or drawn from alternative sources, by keeping containers clean, flushing unused outlets regularly, and ensuring household plumbing is maintained.

"Preventing ***Legionella*** requires practical, consistent action by all parties responsible for water management at different points in the system.

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Water samples are collected from taps in Hillbrow.

"One of the overarching conclusions of this study is that Legionella prevention cannot be addressed through technical interventions alone. It must be understood within the broader context of socio-economic disparity, infrastructure fragility, and service delivery challenges that affect large parts of South Africa, particularly in densely populated, low-income urban areas."

These risks are further intensified by energy insecurity, especially load shedding, which disrupts the consistent heating of water systems and compromises the maintenance of safe temperature thresholds needed to suppress microbial growth.

"Similarly, intermittent water supply due to water cuts or scheduled rationing leads to stagnation within pipes and tanks, conditions that encourage the development of biofilms and the persistence of Legionella bacteria."

Singh says the study's findings will be disseminated widely. An information booklet on water safety and ***Legionella*** prevention will also be distributed to several stakeholders, including building managers and municipal authorities.