How climate change can fuel listeriosis outbreaks in South Africa

The listeriosis outbreak that began in early 2017 in South Africa (SA) is the largest recorded globally.[1] The source of the outbreak was located in early March 2018, when traces of the *Listeria monocytogenes* bacterium were found in a food production facility in Polokwane, Limpopo Province, SA, which produces ready-to-eat processed meat products.[2] By the time the source was identified, about 950 cases of invasive disease had been confirmed and 180 deaths reported, almost certainly underestimates of the actual extent of the disease.[2] Actions to halt the outbreak, such as product recalls and closing implicated processing plants, are clearly an immediate priority, as are steps to enforce environmental health standards. It is also important, however, to pay attention to factors relating to the longer-term, structural environment in which such outbreaks unfold and which may contribute to an increased frequency of cases in the near future. One such factor is climate change, which has garnered little attention thus far in the discourse surrounding the outbreak.

The wide-ranging environmental effects associated with global climate change markedly alter the epidemiology of food-borne diseases, including *L. monocytogenes*.[3] Even though *Listeria* species are ubiquitous within the natural environment, several features of the epidemiology and characteristics of the microbe make it especially climate sensitive. Spikes in ambient temperature and high summer temperature peaks, for example, have been linked to the occurrence of listeriosis, as with most diarrhoeal pathogens.[4-6] Hot weather extremes that become more common with climate change, augment the replication cycles of *L. monocytogenes* and could cause breakdowns in food cooling chains, with rapid rises in numbers of the bacteria on food products.[7] But, aside from temperature increases, altered rainfall patterns and lengthened dry seasons – as we have seen in the western regions of SA – may influence *Listeria* transmission.

L. monocytogenes is classically associated with the food chain, during pre-harvesting and processing and at retail level.[8,9] Water scarcity can compromise hand hygiene, as well as cleaning and sanitising operations in the food products industry. Cleaning hands with sanitisers, increasingly the norm in drought-affected areas, is less effective than washing with soap and water.[10] More importantly, however, in food processing plants, water scarcity may hamper efforts to clean machines used for slicing, chopping or related processes. Intensive, deep cleaning is required to prevent persistence of *L. monocytogenes* on such machines, given that the bacterium can tolerate high salt and nitrate concentrations, desiccation, moderate heat, and both acidic and alkaline conditions.[9] With incomplete cleaning, especially of machines that have 'unhygienic' designs or are damaged, *L. monocytogenes* can persist in harbourage sites (i.e. cracks, niches or other hard-to-reach places).[9] The organisms can adhere to all food contact surfaces, forming biofilms, which are hard to eliminate. In a study in Gauteng, for example, the microbe was isolated from stainless steel surfaces in food plants after they had been cleaned and disinfected using a range of cleaning methods.[11] As could be expected, several studies have detected *L. monocytogenes* in food samples of street vendors, who have limited access to water and cleaning equipment.[12,13] The bacterium has even been found in delicatessens in Johannesburg – in 10% of cleaning cloths.[14] These levels of contamination will possibly rise as water scarcity, which threatens much of the country, further reduces personal and industrial cleaning.

Another way that climate change influences the spread of *L. monocytogenes* is through inducing a switch in the types and sources of water used for agriculture and domestic purposes. When supplies of potable municipal water become limited, both subsistence and commercial farmers resort to using surface water for irrigation, which often naturally harbours *Listeria* species.[15,16] In both rural and urban areas, roof-harvested rainwater is increasingly being used for irrigation and domestic purposes. A study of rainwater tanks in villages in three provinces of SA found that 22% of samples were contaminated with *L. monocytogenes*, possibly from bird faeces and debris on rooftops.[17] The organism also proliferates in water within drainage ditches, which may then contaminate fruits and vegetables when used for irrigation.[3,18]

Changes in precipitation patterns wrought by large-scale climate disruption also impact on *Listeria* dispersal. Rainfall occurring in short bursts of 5 - 10 minutes favours the dispersal of *Listeria* and other pathogens from the soil onto plants, while lengthier downpours exert a washout effect.[3] As with fresh produce, run-off water may contaminate the water in fish farms, an effect especially noticeable during summer months.[19] As this water filters through the fishes' gills, they become contaminated with *L. monocytogenes*, and the organism is then introduced into food processing plants.[20]

In summary, long-term water scarcity can influence cleaning practices and alter water sources in ways that favour the persistence of *Listeria* in food-processing plants, but also in retail outlets and domestic settings. Much closer monitoring of food industry standards, changes in dietary habits of the public and heightened responses to listeriosis outbreaks are required, in conjunction with efforts to increase the volume of potable municipal water and to ensure that all citizens have access to this water.

Ultimately, infectious disease outbreaks, which may become more frequent with rising ambient temperatures and water scarcity, are the proverbial canary in a coal mine. They serve as but one reminder of the devastating effects of climate change presently unfolding in SA. As with all nations, the country needs to takes rigorous steps to prepare for these changes. The high levels of carbon emissions in SA, especially its reliance on coal for power, may well worsen the impact of climate change. In SA, 93% of electricity production is still obtained from coal, more than double the global average (42%), and renewable energy sources account for <2% of electricity compared with a world average of 22%.[21] Also, challenges in public transport in the country, especially with train services,[22] have heightened the use of taxis, cars and other forms of carbon-intensive transport. Without concerted action to prepare for the health effects of climate change, and in the absence of efforts to reduce further environmental degradation, South Africans may face many more large outbreaks of infectious diseases in years to come.

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S Afr Med J 2018;108(6):453-454. DOI:10.7196/SAMJ.2018.v108i6.13274