WATER SERVICES
ASSOCIATION OF AUSTRALIA

FACT SHEET:
Mycobacteria

Mycobacteria and human infection

Mycobacteria are a large group of bacteria that may be classified into two major categories:

- 'Typical' (or tuberculous) mycobacterial species, which are pathogenic to humans and some animals, but are not able to grow in the environment. These typical species include those which cause tuberculosis and leprosy in humans. These diseases are transmitted person-to-person (and in the case of tuberculosis, sometimes animals-to-people), but are not transmitted by water.
- 'Atypical' (or nontuberculous) mycobacterial species that usually grow in soil and natural water environments, but may, under some circumstances, cause infections in humans. The nontuberculous mycobacterial species are collectively known by the abbreviation NTM. Over 150 different NTM species have been identified, and these bacteria are believed to play a role in the breakdown of plant material and the recycling of nutrients in soil. They often grow inside larger microorganisms, such as amoeba and ciliates, in a symbiotic relationship. Growth within a host organism may enhance the ability of NTM to infect humans.

Approximately 25 NTM species have been reported to cause clinically-significant human infections, while a few others appear to colonise sites in the human body (especially the pulmonary system) without causing illness. Several different types of infection may occur:

- pulmonary disease
- lymphadenitis (infection of the lymph nodes)
- eye, skin, tissue or bone infections (often related to a traumatic injury or surgical wound)
- disseminated infection throughout the body.

In many cases there is a prolonged time period, often several months, between the initial NTM infection and the development of illness. Treatment of NTM infection requires prolonged courses of antibiotic therapy, and the infection is often difficult to eliminate. It is believed that most pulmonary NTM infections are acquired by inhalation; however, aspiration (when water or food goes 'down the wrong way' into the lungs when swallowing) is also a plausible mechanism for infection. NTM infections are not transmitted person-to-person.

NTM infections are reported to health authorities in Queensland, South Australia and the Northern Territory, but no national estimate of infections is available. People who are most likely to develop significant NTM infections include those with chronic existing lung conditions (such as chronic obstructive pulmonary disease, bronchiectasis, severe asthma or cystic fibrosis), those with impaired immune systems or those individuals who are taking immunosuppressive drugs (for treating cancer, some inflammatory conditions or the prevention of organ rejection after transplants). Serious NTM infections were common in HIV patients prior to the development of effective HIV therapies, but are now much less frequent. NTM infection is also more common among smokers, and in older age groups. Recent evidence indicates that gastro-oesophageal reflux disease is associated with NTM infection and it has been suggested that bacteria regurgitated from the stomach can be aspirated into the lungs.

In addition to occurring in water and soil, mycobacteria have been found in potting mix, sphagnum moss and other types of moss, peat, household dust and cigarettes. They also occur in many foods including

fruits, vegetables, meat, fish, poultry, eggs and dairy products. Clinically significant NTM species can generally grow at temperatures in the range of 35 °C to 37 °C, and some species survive for prolonged periods at temperatures as high as 50 °C.

Mycobacteria in water supplies

Drinking water is not routinely monitored for the presence of mycobacteria, and there is limited information on the occurrence or concentrations of these bacteria in drinking water systems. Internationally, no standards or guideline values have been established for mycobacteria in drinking water systems.

Mycobacterial species are present in natural water sources from which drinking water is drawn, and in contrast to most other bacteria, these microorganisms are relatively resistant to drinking water disinfection processes. This resistance is attributable to the thick cell wall, with its high lipid content, which is common to all mycobacteria. The cell wall is believed to slow down the absorption of nutrients into the cells, thus limiting their growth rate, but it also protects the cells against toxic chemicals (including disinfectants and antibiotics) and adverse environmental conditions (such as dehydration and pH extremes), which may kill more rapidly-growing microorganisms.

Mycobacteria are believed to grow mainly as a component of biofilms attached to pipe surfaces within water supply systems, although they can also be found in the water phase. The composition of the mycobacterial cell wall also plays a role in enabling strong attachment to solid surfaces, and an affinity for air-water interfaces. This enhances the ability of mycobacterial species to persist in water systems, even systems with fast water flows, and causes these cells to preferentially partition into water aerosols.

Maintenance of a disinfectant residual in water supply systems has been generally regarded as an effective means to reduce risks from a range of microbial pathogens, but this measure appears to be largely ineffective against mycobacteria. Research has shown that levels of chlorine-based disinfectants that kill other microorganisms in pipe biofilms may have little effect on mycobacterial numbers. One US study in a system that switched from chlorine to chloramine disinfection showed a reduction in the rate of *Legionella* colonisation, but an increase in mycobacterial colonisation. This raises the possibility that efforts to reduce risk from one pathogen in water systems may have the unintended consequence of increasing exposure to another. It is not clear whether good management practices such as flushing and disinfection after repairs, and regular cleaning of sediment from pipes and storage tanks have any significant effect on mycobacterial growth in water distribution systems.

Mycobacteria also occur in water systems where chlorine-based disinfectants are not used, such as those in the Netherlands. A study of eight Dutch water supplies found NTM in all systems, and with abundance increasing through the distribution systems, compared to levels at the associated water treatment plants. Reduction of nutrient levels in water has also been advocated as a possible means of controlling mycobacteria, but in the Dutch study the nutrient levels in water appeared to have no effect on mycobacterial numbers, while higher water temperatures were associated with increased abundance. Current understanding of mycobacterial ecology in water supply systems and their interactions with other potential pathogens is limited, and there is insufficient knowledge to formulate control strategies to reduce the prevalence of NTM in water distribution systems.

Management of mycobacterial risks

At present, it is not known what proportion of NTM infections are attributable to water exposure and what proportion arise from other sources, such as uncooked foodstuffs, or exposure to dust and soil that contain mycobacteria.

Genetic typing of mycobacterial isolates from tap water supplies and those found in patients with NTM

disease, have suggested that household or hospital water supplies may be a source of infection in some patients. Similar studies have also found genetic matches between isolates from patients and NTM strains in potting mix. However, for most patients, no match with potential environmental sources can be identified, and the discriminating power of some genetic typing methods is uncertain. The long time lag between the initial NTM infection, the development of symptoms and the sampling of the possible environmental sites where the infection may have been acquired makes interpretation of results and tracing of sources difficult.

Current medical advice to people considered at high risk of NTM infection is to ensure that hot water storage systems are set at 60° C to prevent growth of NTM, to minimise exposure to aerosols from showers, spas and humidifiers, and avoid inhalation of potting mix or soil. In the hospital setting it is important to avoid the use of unsterile water for the rinsing medical equipment used for invasive procedures, or for the bathing surgical wounds or injection sites.

Trends in occurrence

Overall, NTM-related disease appears to be increasing in many countries, but it is not clear to what extent this is due to demographic changes (ageing populations resulting in more people in 'at risk' age groups), susceptibility changes (a larger percentage of people having underlying risk factors), increasing clinical testing rates and better diagnosis, or increasing exposure. NTM infections in healthy people are relatively rare; however, an increasing rate of NTM infections in slender middle-aged women without known risk factors has been recently reported in some countries, although the reasons for this are not understood.

Warmer water temperatures associated with climate change effects may lead to increased growth of biofilms and NTM in water supply systems and building plumbing.

More information is available from your State or Territory Health Department.

References

American Thoracic Society (2007). An Official ATS/IDSA Statement: Diagnosis, Treatment, and Prevention of Nontuberculous Mycobacterial Diseases.
http://www.thoracic.org/statements/resources/mtpi/nontuberculous-mycobacterial-diseases.pdf

Halstrom S., Price P, and Thomson R. (2015) Review: Environmental mycobacteria as a cause of human infection. International Journal of Mycobacteriology 4: 81-91.