Environmental Mycobacteria: Emerging Pathogens Lurking Closer to Home!

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While mycobacteria are well-known causes of tuberculosis (TB) and leprosy, many other species, variously called ‘nontuberculous mycobacteria’, ‘atypical mycobacteria’ and ‘mycobacteria other than tuberculosis’, are emerging pathogens of global significance. In contrast to the causes TB and leprosy, such species come from soil and water. Therefore, the term ‘environmental mycobacteria’ (EM) is used here to signify the environment as their primary habitat. Potting soil, hot water tanks, water coolers, ice machines, humidifiers, potable water distribution systems and other sites with stagnant water are among their reservoirs indoors. Thus, they lurk virtually everywhere inside our homes and hospitals (Lande et al. 2019). Figure 1 shows how exposure to EM can occur.

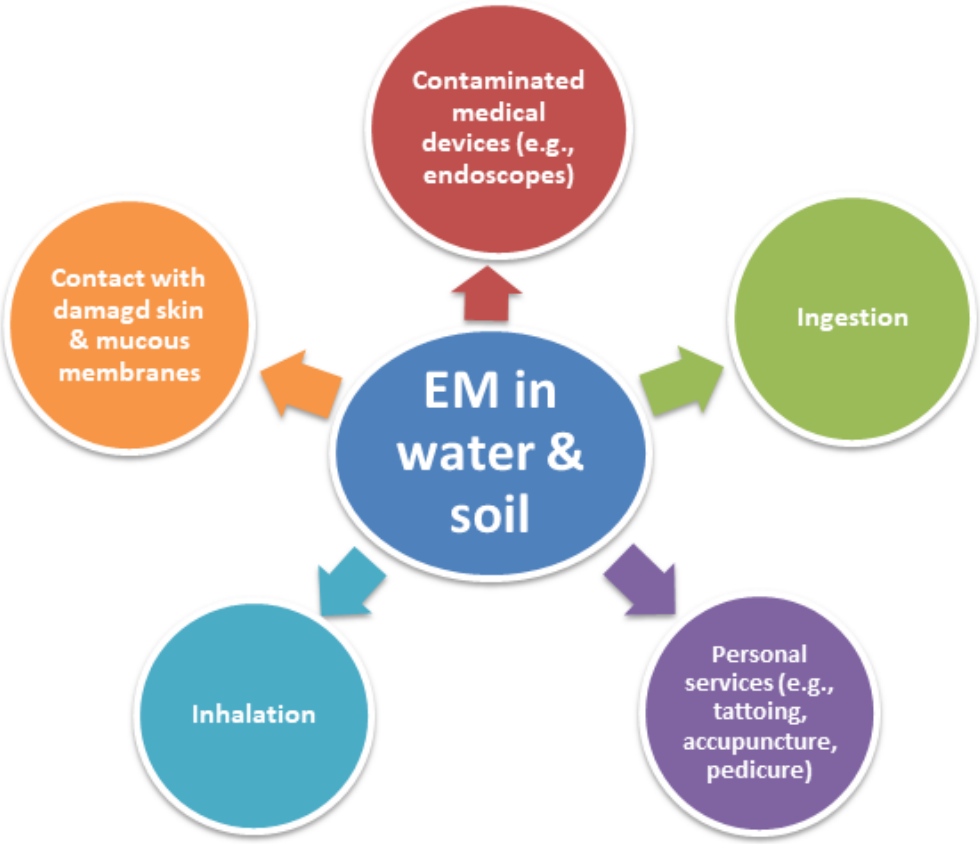

Figure 1. Possible means of human exposure to EM in water and soil

EM are a good example of ‘perikairots’ (Sattar 2013), which are environment-based opportunists. While they are particularly dangerous to the health of those debilitated by age, AIDS, cystic fibrosis (CF) or chronic obstructive pulmonary disease (COPD), otherwise immunocompetent persons can also succumb to them. Notably, EM are not known to cause secondary cases of infection!

Table 1 lists examples of such species and the infections they can cause.

Species	Infection(s)
M. abscessus	Skin wounds and post-surgical soft tissue sites. Also, among the EM frequently isolated from cystic fibrosis patients.
M. chelonae	Subcutaneous nodules at mesotherapy injection sites of substances for cosmetic purposes.
M. avium complex	*M. avium* and *M. intracellulare* together are a common cause of lung infections, particularly in HIV-infected patients.
M. gordonae	Lung infections in HIV patients.
M. kansasii	Of all the EM, it is the second most common cause of lung infections associated with AIDS.
M. malmoense	Lung, skin and tissue infections as well as cervical lymphadenitis.
M. marinum	Swimming pool granulomas from exposure to water in swimming pools or in home aquaria.
M. xenopi	Among the EM species frequently associated from patients with AIDS
M. immunogenum	Hypersensitivity pneumonitis (HP) from inhalation of EM-containing aerosols from metalworking fluids.
M. ulcerans	Buruli ulcer, a skin infection, occurs in >30 tropical and subtropical countries in West and Central Africa.

Table 1. Some examples of EM and the infections that they can cause in humans

Testing chemicals for their mycobactericidal activity

The genus *Mycobacterium* contains aerobic bacilli with a waxy coating, requiring ‘acid-fast’ staining for microscopy. They are also generally more challenging to culture while many pathogenic species requiring several weeks of incubation for visible growth. Therefore, standards-setting organizations such as ASTM International and AOAC International have separate methods for testing chemicals for their mycobactericidal activity (Sattar 2013). Interestingly, such testing focused not only on their tuberculocidal activity, but also as an indicator of a formulation’s ability to inactivate the hepatitis B virus, which remains refractory to culture in the lab. However, the continuing emergence of EM as human pathogens has now widened the need to test environmental surface as well as medical device disinfectants. This widening of the focus also requires that the term ‘tuberculocidal’ be replaced with a more inclusive and scientifically valid term ‘mycobactericidal’.

Features of EM as human pathogens are summarized in Table 2.

- Higher risk of morbidity in cases of cystic fibrosis and chronic obstructive pulmonary disease.
- Co-infections common in those with AIDS.
- >80,000 cases of pulmonary disease alone in the U.S; more difficult to treat than cases of respiratory TB.
- Can infect the immunosuppressed (opportunists) as well as the immunocompetent; increased susceptibility with advancing age.
- Treatment may require a combination of several antibiotics for long durations, reinfections occur in about 30% of the treated.
- The ubiquity of EM mandates extra care in linking lab isolates with the etiology of a given infection.
- Implicated in pseudo-outbreaks where the same organism may come from an environmental source (e.g., tap water) but not from infected or colonized patients.
- Medical tourists acquiring serious Infections during cosmetic surgery.
- Most frequently isolated pathogens in waterborne outbreaks.
- Not known to cause secondary cases.
- Main reservoirs are peat-rich potting soil and water-based biofilms.
- Well-adapted for growth in drinking water distribution systems due to relative resistance to water disinfectants (e.g., chlorine), and the ability to eke out nutrients even from low concentrations of organic matter.
- Reduction in risk of exposure by avoiding inhalation of peat-rich potting soil and aerosols from showers, hot tubs, and humidifiers.
- Association with amoebae in the water environment may select for increased virulence for humans.
- Cause of hypersensitivity pneumonitis (HP) from inhalation of EM in metal working fluids; HP is a debilitating and potentially fatal occupational hazard.
- Grow in natural as well as constructed settings such as cooling towers and premise plumbing.

Table 2. Features of EM as human pathogens
https://www.lung.org/lung-health-and-diseases/lung-disease-lookup/nontuberculosis-mycobacteria/learn-about-ntm.html

As indoor air is the primary vehicle for the spread of respiratory TB and EM, protecting air quality is crucial to reduce their airborne spread. Similarly, proper disinfection of heat-sensitive medical devices, another important aspect of routine infection prevention and control, aims to address the threat from both TB and EM. In this context, the choice of a surrogate for disinfectant testing is still under debate. Testing using *M. bovis,* required for regulatory approval, is quite challenging as the organism not only takes several weeks to grow in the lab, but its behavior also is often unpredictable. *M. terrae* is one among the current favorites because it grows nearly twice as fast as *M. bovis* with a consistent growth pattern along with a general disinfectant resistant profile predictive of that of the tubercle bacillus.

Further Reading

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Halstrom S. et al. (2015). Review: Environmental mycobacteria as a cause of human infection. Int J Mycobacteriol. 4:81-91.

Lande, L. et al. (2019). *Mycobacterium avium* in community and household water, suburban Philadelphia, Pennsylvania, USA, 2010–2012. Emerg Infect Dis. 25: 473-481; 2019.

Sattar, S.A. (2013). Testing of chemicals as mybactericidal agents. *In* Principles and Practice of Disinfection, Preservation and Sterilization. Blackwell Publishing Ltd., Oxford, U.K. Pages 131-141.

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