



## MYCOBACTERIA: DRINKING WATER FACT SHEET

### GENERAL INFORMATION

- *Mycobacteria* belong to the
  - < Order Actinomycetales,
  - < Family Mycobacteriaceae, and
  - < Genus Mycobacterium.
- There are approximately 90 recognized species of *Mycobacteria*, over 20 of which are known to cause disease in humans.
- Non-tuberculosis mycobacteria (NTM) have been identified in numerous environmental sources, including water.
- There has been recent interest in the NTM species, due to their ability to cause disease in humans and animals after environmental exposures.

#### Characteristics and Classification:

- *Mycobacteria* are rod-shaped bacteria which require oxygen for growth. Each species has an acid-fast staining property during some stage of its growth cycle.
- Mycobacterium have been referred to as the 'ducks of the microbial world' due to their thick, waxy, outer coating which enables them to thrive in aquatic environments.
- The various species of *Mycobacteria* are classified based on their growth

rates in culture into the following three categories: slow growers, rapid growers and those not yet cultivated.

### ENVIRONMENTAL OCCURRENCE

- NTM have been found to be ubiquitous in the environment.
- NTM species have been isolated from numerous water sources, including waste water, surface water, recreational water, ground water and tap water.
- Piped water supplies are readily colonized by mycobacteria. Biofilms may serve as a reservoir for these opportunistic pathogens.
- Few studies are available which quantify the concentrations of NTM in water. Some reports indicate that NTM have been recovered in 11% to 38% of raw water samples at concentrations of <0.1 to 48 organisms per milliliter of water.

### HEALTH EFFECTS IN HUMANS

#### Transmission to Humans:

- NTM are not thought to be transmitted by the human to human route, but are instead thought to be transmitted from environmental sources.

- Exposure pathways of potential concern include ingestion, inhalation and entry of organisms through abraded skin.

### **Symptoms:**

- The clinical symptoms seen following infection with NTM depend greatly on the mycobacterial species.
- Common clinical syndromes include:
  - < Pulmonary infection
  - < Infection of the lymph nodes
  - < Ear infection
  - < Skin & soft tissue infection
  - < Catheter-associated infection
  - < Whole Body (e.g., blood) infection
- In general, symptoms seen in children are similar to those reported in adults. Pulmonary disease is relatively rare in children. The most common form of clinically significant NTM infection in children is infection of the lymph nodes in the neck.

### **Treatment:**

- Treatment of NTM infection depends on the location and extent of disease involvement, status of the host's immune system, and the mycobacterial species.
  - < Treatment of pulmonary and whole body infections most often requires a multidrug regimen.
  - < Treatment for cutaneous lesions may include surgical removal or drug therapy. Often, cutaneous lesions will disappear without requiring treatment.

### **Disease Occurrence and Outbreaks:**

- NTM diseases are not reportable, therefore, information regarding the occurrence of disease outbreaks is

likely to be underestimated. However, human infections due to NTM appear to be increasing at a significant rate across the United States.

- CDC estimates that NTM diseases (non-AIDS related) occur in 1.8 out of 100,000 individuals per year in the U.S., of which approximately 72% are attributable to *M. avium* complex (MAC).
- It has been estimated that in the U.S., 25% to 50% of individuals with AIDS will develop NTM diseases, primarily attributable to MAC. The recent use of highly active anti-retroviral therapy (HAART) in AIDS patients suggests a decrease in the risk and rate of NTM infections in these individuals.
- Waterborne NTM have been associated with hospital (nosocomial) outbreaks worldwide. These disease outbreaks usually involve sternal wound infections, plastic surgery wound infections or postinjection abscesses. Mycobacterial infections in patients undergoing dialysis treatment have also been reported.
- Although not reported frequently, some outbreaks of mycobacterial infection have been reported after exposures in public swimming areas.
- Some false outbreaks have been reported as a result of contaminated sampling equipment or water supplies used for diagnostic procedures. Therefore, it is important that precautions be taken when performing diagnostic tests in order to lessen the chance of false-positive test results.

## HEALTH EFFECTS IN ANIMALS

- Several of the NTM species are known to cause disease in animals. These include MAC, *M. marinum*, *M. ulcerans*, *M. paratuberculosis*, *M. simiae*, *M. fortuitum* and *M. smegmatis*.
- Symptoms seen following infection depend on the host organism and the species of NTM.
- *M. paratuberculosis* is the causative agent of Johne's disease; a slow, progressive infection of the intestine which occur mainly in cattle, sheep and goats.
- *M. marinum* is an important cause of death and economic loss in fish populations.
- *M. fortuitum* and *M. smegmatis* are known to produce mastitis in sheep and cattle and skin and soft tissue disease in domestic house cats.
- Destruction or isolation of infected animals is the most common form of treatment, however, drug therapy has been successful in some cases.

## RISK FACTORS

- The general population (healthy individuals) is fairly resistant to infection.
- Certain individuals are at increased risk for developing NTM associated diseases due to the presence of predisposing factors, including:
  - < traumatic breaches of the skin
  - < pre-existing pulmonary disease or damage
  - < lung architectural defects

- < bronchiectasis
- < generalized congenital and acquired immunosuppressive disorders (e.g., HIV)

## ANALYTICAL METHODS

- The most common method for the identification of mycobacterial species in water samples is through culture isolation. The bacterial culture is evaluated for morphology, growth rates and other biochemical parameters in order to determine the species.
- Several other methods have been developed for the detection of mycobacteria in samples, including:
  - < Polymerase chain reaction (PCR)
  - < Radiometric methods (BACTEC)
  - < GC/MS
  - < Nucleic acid probes
- Although promising, these methods only provide qualitative information regarding the presence of mycobacteria in water and do not provide a measure of concentration.
- When collecting samples for use in culture isolation, a decontamination step is necessary to kill the other bacteria and fungi present in the water. This is because there is a large problem of contamination of samples due to the presence of non-mycobacterial bacteria which are capable of growing at faster rates than the species of interest. Acids, alkalis and detergents are often used during the decontamination process since mycobacteria are generally more resistant to these chemicals than are other bacteria.

## WATER TREATMENT

- In general, two mechanisms can be used to eliminate microbes from drinking water: removal or disinfection.
- Removal treatments such as filtration, sedimentation, coagulation, flocculation and adsorption are primarily physical operations that remove bacteria from the water.
- Disinfection treatment technologies may kill bacteria using chemicals such as chlorine, ozone, bromine, iodine or hydrogen peroxide which are added to the water, or may inactivate microbes via UV radiation.
- NTM are relatively resistant to standard water disinfection procedures and, therefore, can occur in potable water.
- Overall, there is little information available regarding the effectiveness of various disinfection treatments on mycobacterial species in water. However, EPA is actively studying methods to reduce the occurrence of *Mycobacteria* in drinking water and will update this fact sheet when better information becomes available.

zero organisms (bacteria and viruses), including mycobacteria, for drinking water. An MCLG is a non-enforceable guideline based solely on an evaluation of possible health risks, taking into consideration a margin for public safety.

## ADDITIONAL INFORMATION

- EPA has established the Safe Drinking Water Hotline, a toll-free number for further information on drinking water quality, treatment technologies, and for obtaining Health Advisories or other regulatory information.
- Safe Drinking Water Hotline:  
800-426-4791  
9:00 a.m. - 5:30 p.m. (Eastern Time)  
Monday-Friday (excluding holidays). Your state or county health officials or experts in your state's Department of Environmental Protection or Natural Resources may also be of assistance.

## REGULATORY INFORMATION

- EPA has established a Maximum Contaminant Level Goal (MCLG) of