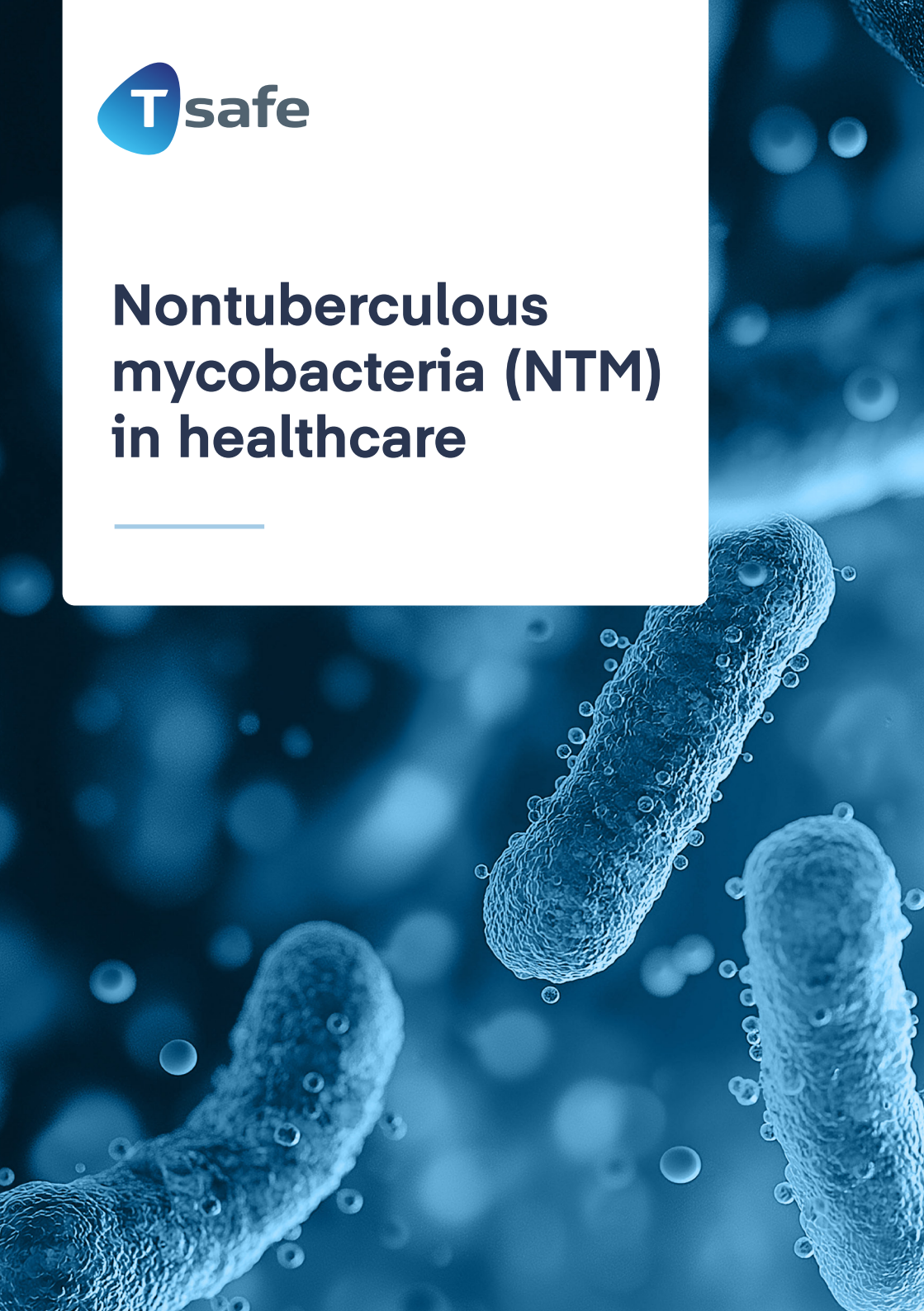
Tsafe

Nontuberculous mycobacteria (NTM) in healthcare



What are NTM?

Nontuberculous mycobacteria (NTM) are a genus of bacteria known for their thick, waxy cell walls, which contribute to their resilience and resistance to many antibiotics and conventional water treatment controls, such as temperature and biocides.

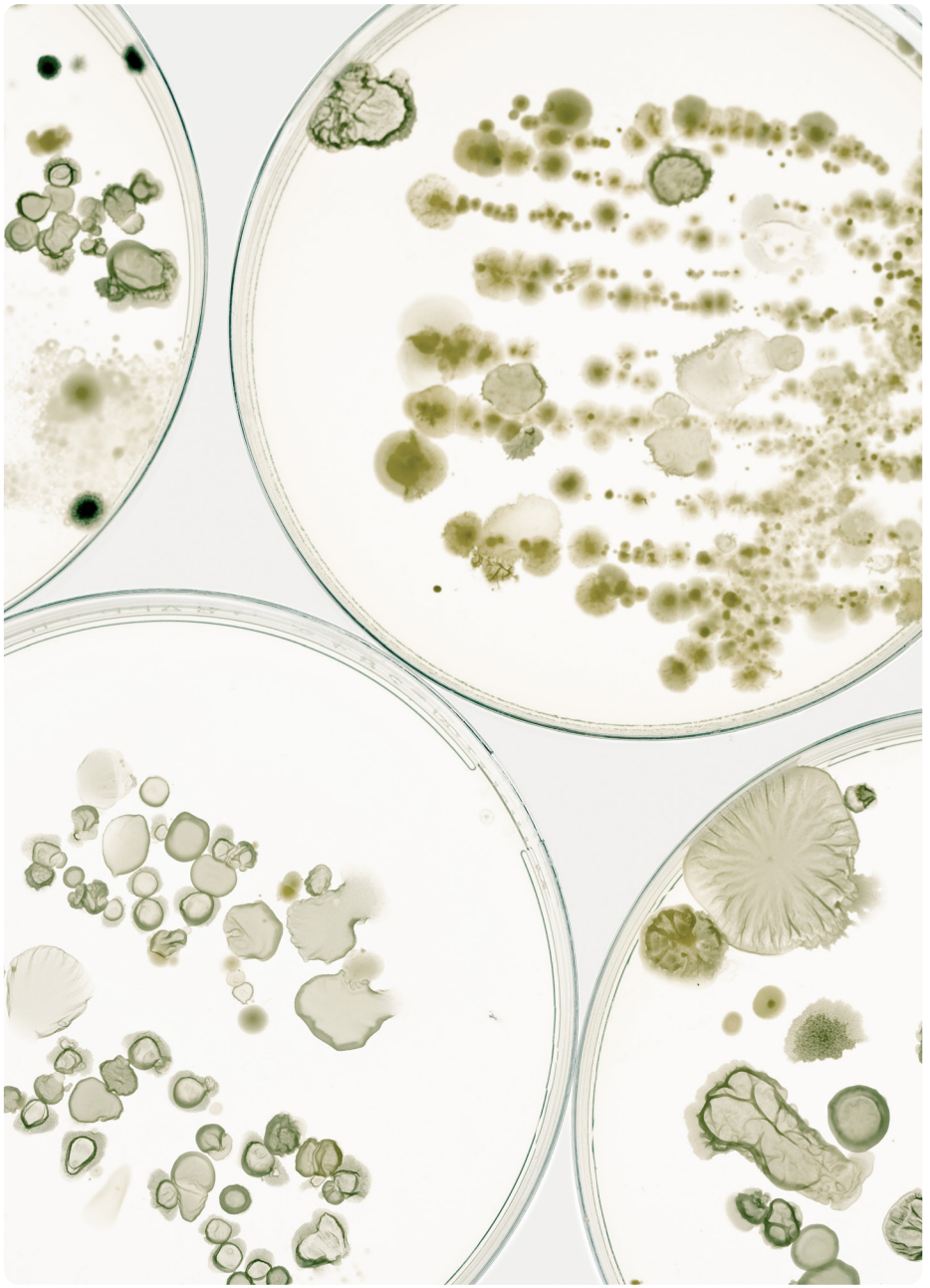
Mycobacteria, found in domestic water systems, primarily refer to a group of nontuberculous mycobacteria (NTM) that naturally occur in the environment, including water and soil. They belong to the family Mycobacteriaceae and include both pathogenic and non-pathogenic species.

They are a significant concern due to their presence in healthcare settings and the environment. This group of bacteria includes species that can cause infections in humans, particularly those with compromised immune systems or pre-existing health conditions.

> **NTM are categorised by NHS England as emerging human pathogens of concern as the number of cases are increasing. Pulmonary NTM infections have been rising, with estimates indicating that the prevalence is around 2.9 cases per 100,000 population.**

Key characteristics

NTM have the potential to be categorised as either rapid-growing (visible in up to seven days to appear on culture media in the laboratory) or slow-growing (which can take several weeks). Both types can pose a risk of life-threatening hospital-acquired infections (HAIs) in high-risk patient groups, especially those who are immunocompromised and more susceptible to infection as a result of illness or treatment.



Risk from NTM in healthcare

NTM are opportunistic pathogens that present a significant risk in healthcare environments due to their ability to cause various infections in vulnerable immunocompromised populations combined with their resistance to antibiotics. In addition, they are resistant to common water treatment control measures used to control Legionella and Pseudomonas, enabling them to thrive in water systems, on surfaces, and in medical equipment and devices.

This makes them a persistent source of HAIs, posing a significant threat, especially to those with weakened immune systems, such as cancer patients, organ transplant recipients, and people with HIV/AIDS. These patients are more susceptible to pulmonary infections, skin and soft tissue infections, and disseminated diseases caused by NTM.

Specific at-risk groups include

1. Lung transplant patients
2. Cystic fibrosis (CF) patients
3. Haematology/oncology patients
4. Solid organ transplantation after intensive treatment
5. Allogeneic stem cell transplantation
6. Any patient with a long line (e.g., central venous catheter) in situ

NTM infections in healthcare

Mycobacterial infections vary depending on the mycobacteria species involved and the infection site. *Mycobacterium tuberculosis* (the cause of tuberculosis) and NTM can cause significant illness, but they affect different body systems and populations.

Pulmonary (Lung) Infections
These are the most common mycobacterial infections, especially with NTM, such as *Mycobacterium avium complex* (MAC), *M. abscesses*, and *M. kansasii*. The symptoms often resemble those of tuberculosis and other lung diseases.

Skin and Soft Tissue Infections
Certain rapidly growing mycobacteria, such as *Mycobacterium fortuitum*, *M. chelonae*, and *M. abscesses*, can cause skin infections, often following trauma, surgery, or cosmetic procedures.

Disseminated Infections
These are infections that spread throughout the body and are most commonly seen in immunocompromised individuals (e.g. HIV patients or those on immunosuppressive therapy).

Surgical Site and Device-Related Infections
Mycobacteria can contaminate medical equipment or surgical sites, particularly in procedures involving water or invasive devices.

NTM of clinical concern

Several critical species of NTM are associated with waterborne infections in healthcare environments. These species are naturally found in water systems and can cause various infections, particularly in individuals with compromised immune systems or pre-existing lung conditions.

NTM Species	Sources	Health Impact	Mean size (diameter x length)
Mycobacterium abscessus	Present in water and soil, with a significant presence in taps, showers, drinking water dispensers, water coolers and electronic outlets in hospitals.	Associated with severe pulmonary infections, particularly in individuals with cystic fibrosis, as well as skin and soft tissue infections. This species is known for its resistance to antibiotics, making infections difficult to treat.	0.5 µm x 1.75 µm
Mycobacterium avium Complex (MAC), *Mycobacterium avium, Mycobacterium intracellulare, and Mycobacterium chimaera*	Commonly found in domestic water systems, including taps, showerheads, and heater-cooler units.	Causes pulmonary infections, particularly in people with chronic lung conditions. MAC is one of the most common NTM species in water associated with human infections.	0.4 µm x 1.79-5.5 µm
Mycobacterium fortuitum	Found in tap water, soil, and dust. It can survive in water systems, leading to potential exposure through household water.	Causes skin, soft tissue, and occasionally pulmonary infections. It is also associated with infections related to surgical wounds or contaminated medical devices.	0.75 µm x 3 µm
Mycobacterium kansasii	Frequently isolated from tap water and water distribution systems.	Known for causing lung disease that mimics tuberculosis, including symptoms like chronic cough and weight loss. It is one of the most significant NTM pathogens in the UK.	0.4 µm x 5.5 µm
Mycobacterium xenopi	Found in hot water systems, including those in hospitals, making it a concern for nosocomial infections.	Causes pulmonary infections, especially in individuals with underlying lung diseases. It is also known to be resistant to standard water disinfection practices.	0.4 µm x 5.45 µm

Note: this list is not exhaustive.

Sources of NTM infection in healthcare

NTM can thrive in various areas within healthcare environments, particularly where there is water, biofilm formation, or moisture. These bacteria are resilient and can persist in hospital water systems, medical devices, and other moist areas due to their natural resistance to disinfectants, temperature, and their ability to form biofilms.

Potential sources of infection

- Showers, taps, and associated drainage
- Water and ice used for drinking, food preparation and post-surgical wound management
- Water used in patient diagnosis and treatment, including water used for cleaning and decontamination of instrumentation
- Water used for personal hygiene
- Water used for environmental cleaning
- Toilet flushing
- Fittings, components, and equipment which has been wet tested during manufacture

Routes of transmission

NTM are transmitted to patients primarily through exposure to contaminated water sources, medical devices, or aerosols. In healthcare environments, there are several pathways through which patients can become infected:

Inhalation

The most common infection pathway for NTM is through the inhalation of aerosolised water droplets.
Once inhaled, the bacteria can establish infections in the lungs, particularly in individuals with pre-existing lung conditions such as chronic obstructive pulmonary disease (COPD), bronchiectasis, or cystic fibrosis.

Direct Contact

NTM can enter the body through cuts, abrasions, or surgical wounds, leading to skin and soft tissue infections. These infections are often associated with exposure to contaminated water or surgical instruments.

Ingestion

Although less common, ingesting contaminated water and ice used for drinking and food can lead to gastro-intestinal infections. Ingestion can sometimes lead to a systemic infection, especially in people with weakened immune systems, such as those with HIV/AIDS.

Medical Equipment

Infections can occur through the use of contaminated devices, such as perfusion equipment, endoscopes, bronchoscopes, or dialysis machines, leading to local-ised infections or, in some cases, more severe systemic infections.

Challenges of managing NTM infection

NTM can colonise a wide range of hospital water systems and associated equipment and are resistant to conventional control measures typically employed for other waterborne pathogens such as *Legionella Spp.* and *Pseudomonas aeruginosa*. These characteristics, combined with limitations in sampling and detection of NTM, pose a significant challenge to healthcare estates and IPC teams in the management and prevention of infections.

Resistance to disinfectants

NTM are notoriously resistant to standard water treatment disinfection methods. Studies using *M. avium complex* (MAC) strains showed that they are almost 1,000-fold more tolerant of chlorine, chloramine, ozone, and chlorine dioxide compared to *Escherichia coli (Taylor et al., 2000)*.

Biofilms

NTM are known to be particularly hardy. They can grow in low nutrient and low oxygen conditions and multiply within protozoa and biofilms, making them persistent in complex water systems.

Tolerance to temperature

Depending on the species, NTM can also survive at relatively high water temperatures. This includes temperatures typically used to control microbiological growth in domestic hot water systems (>50^{0}C).

Sample detection

Many species of NTM grow slowly, taking days to weeks to form colonies. This, combined with a lack of standardised methods, means that sensitivity and specificity of detection vary between laboratories, making it difficult to interpret results and assess risk.

Controlling NTM with point-of-use filters

Considering the many challenges in managing NTM, point-of-use (POU) filters can offer an immediate and effective solution for preventing NTM infections in water safety emergencies or as a precautionary control measure in high-risk settings.

POU filters provide a physical barrier to the release of harmful opportunistic waterborne pathogens, acting as a critical infection prevention and control measure in water safety emergencies. Traditionally used to prevent exposure to *Legionella Spp.* and *Pseudomonas aeruginosa* in hospitals, it is well documented that POU filters are also effective in controlling the release of NTM from outlets.

As NTM typically range from 0.4 µm - 5.5µm in size, filters that can demonstrate 0.2 µm absolute sterilising grade retention efficacy can provide an effective and reliable barrier to their release at the point of use.

Advantages

- Immediate and reliable control
- Easy to install in water safety emergencies
- Effective precautionary control in high-risk settings
- Solutions for tap, shower, drinking water, and ice machines
- Solutions for medical devices, including heater-cooler units and rinse water

T-safe medical water filters NTM retention efficacy

The microbial retention efficacy of T-safe medical water filters against NTM and other waterborne pathogens has been proven through independent simulated laboratory lifecycle studies, under conditions commonly found in healthcare water systems.

Absolute retention of NTM

Trial set up

The purpose of the trial was to test the microbial retention efficacy of T-safe medical water filters when exposed to both a constant and spiked challenge of Mycobacterium and other waterborne pathogens, in accordance with the principles of ASTM F838, over their prescribed lifecycle of 31 days.

T-safe Medical Tap and Shower Filters were installed on a purpose-built water system and subjected to the constant exposure of high concentrations of *Mycobacterium spp*. through simulated intermittent daily flushing cycles to replicate everyday use. On days 1, 10, 20, 30 and 40, the filters were challenged with an additional spiked solution of *Mycobacterium spp*. via an injection point pre filter. On day 40, the filters were further challenged with a range of additional pathogens via injection point pre-filters, including *S. maltophilia, A. baumannii, S. marcesens, K. pneumoniae, B. cepacia, S. paucimobilis*.

Water Sampling of the filtrate water was undertaken from each filter after each spiking episode, and both pre-flush and post-flush sampling was included.

Results

T-safe Medical Water Filters demonstrated absolute retention of all test organisms in pre- and post-filtrate samples collected on days 1, 10, 20, 30, and 40 of the trial.

The absolute retention of the spiked bacteria at day 40 proves the reliability of the 31 day lifespan of the filters against a range of organisms including;

- *M. abscessus*
- *M. abscessus bollettii subspecies*
- *M. chimaera*
- *S. maltophilia*
- *A. baumannii*
- *S. marcescens*
- *K. pneumoniae*
- *B. cepacia*
- *S. paucimobilis*

Guidelines

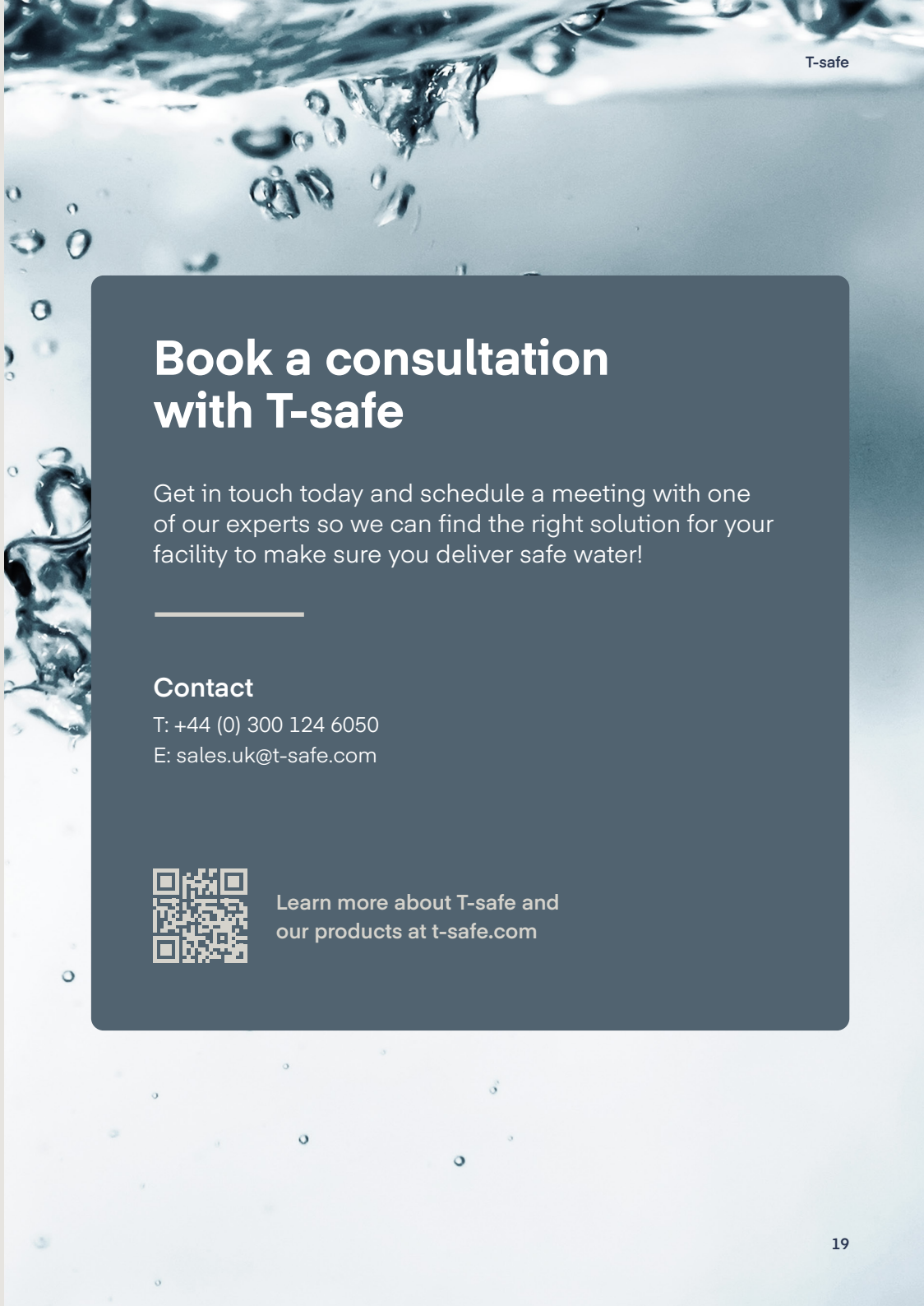
What guidelines are there to protect patients against NTM infections?

The first definitive guidance for the control of NTM in healthcare water systems was published on 27th August 2024 as an NHS Estates Technical Bulletin (NETB).

NETB No. 2024/3 Designing safe spaces for patients at risk of infection from nontuberculous mycobacteria and other waterborne pathogens.

The technical bulletin was developed to enhance the current HTM 04-01 (2016) guidance in response to an outbreak of *M. abscessus*, a nontuberculous mycobacterium associated with a newly constructed lung transplant unit. Although the new guidance focuses on new construction and major refurbishment projects, its scope also applies to existing buildings where the infrastructure allows to protect patients at high risk of water and wastewater infections.

Read the full bulletin here



Book a consultation with T-safe

Get in touch today and schedule a meeting with one of our experts so we can find the right solution for your facility to make sure you deliver safe water!

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Learn more about T-safe and our products at t-safe.com

Delivering Safe Water