

Nontuberculous Mycobacteria in Households

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NTM in Drinking Water

- **Source**

Surface: NTM-rich, particulate-associated

Groundwater: NTM rare

- **Treatment Plant**

Reduction of NTM numbers (100-10,000-fold)

Disinfectant (Cl, ClNH₂, ClO₂, O₃)-resistant

- **Distribution System**

NTM growth in pipes @ $\geq 50 \mu\text{g AOC/L}$

- **Household Plumbing?**

NTM in Drinking Water Distribution Systems

- Eight drinking water distribution systems across the United States sampled
- NTM recovered from 81 of 528 samples (15 %)
- Ground water source systems = NTM-free
- High source water turbidity = High NTM numbers
- Treatment reduced NTM numbers 10^2 - 10^4 -fold
- High AOC values correlated with increase in NTM numbers in distribution system

Falkinham et al. Appl Environ Microbiol 67: 1225 (2001)

Sources of NTM

- Natural and engineered water systems
- Household water systems (showers)
- Swimming pools, hot tubs, spas, therapy baths
- Hospital solutions and ice
- Refrigerator water taps (new)
- In-line filters

Falkinham. Environ Microbiol Rpts 1:477 (2009)

Preferred Habitats of NTM

- Biofilms on surfaces of pipes, taps, and showerheads
Falkinham et al. *Water Hlth* 6: 209 (2008)
- Biofilms in filters
Falkinham. *J Med Microbiol* 59:1198 (2010)
- Disinfected habitats including:
 - Drinking water distribution systems
 - Hot tubs and spas (Embil et al., *Chest* 111: 813, 2002)
 - Foot baths (Winthrop et al., *NEJM* 346: 1366, 2002)
- Metal recovery fluid
 - Falkinham. *Appl Environ Microbiol* 75: 2057 (2009)

Conditions Selecting for NTM in Household Plumbing

Condition

- Low disinfectant
- Low AOC
- Stagnant
- Heated Water
- Flowing System with Pipe Surfaces

NTM Characteristic

- NTM disinfectant-resistant
- NTM grow @ $\geq 50 \mu\text{g AOC/L}$
- NTM grow @ 6 % air
- NTM survive @ 50°C
- NTM hydrophobic, prefer surface attachment; biofilm

Household Plumbing Samples

- **Water:** 500 mL hot and 500 mL cold
- **Water Heater:** 500 mL sediment and 500 mL water
- **Biofilm:** swab placed in 2 mL sterile tap water
 - hot and cold water taps
 - refrigerator water tap
 - showerheads
- **Filters:** swab (in 2 mL sterile tap water) or whole filter
 - in-line
 - point-of-use

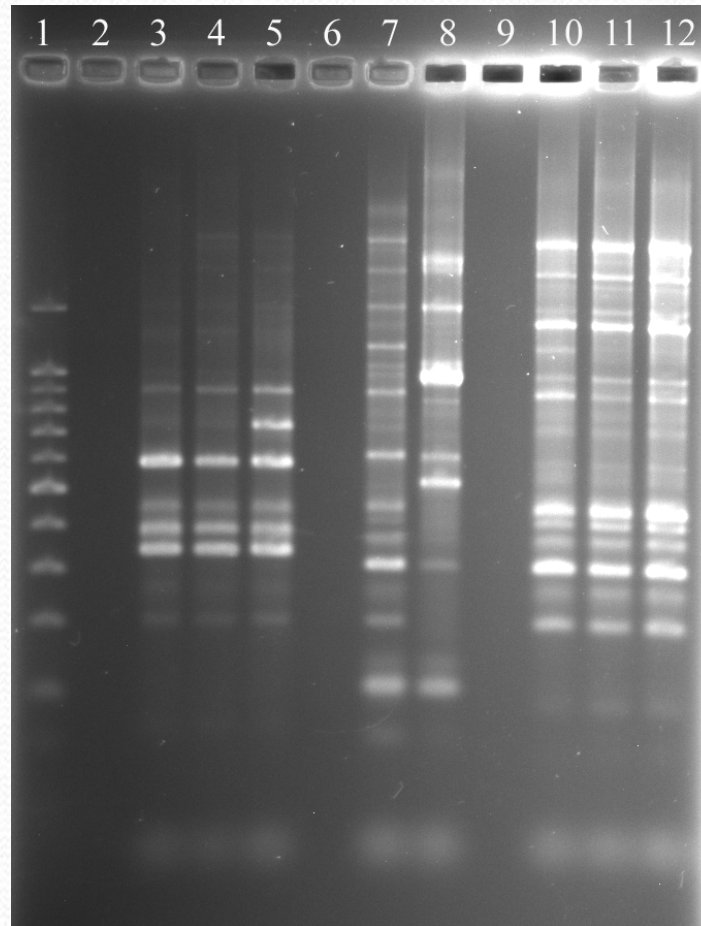
Nontuberculous Mycobacteria in Households

• Patients	31
• Households Sampled	37 ^a
• Households with NTM	22 (59 %)
• Total Samples Collected	394
• Samples with NTM	109 (28 %)
• Household & Patient Same NTM Species	17 (46 %)
• Household & Patient NTM Same Fingerprint	7 (41 %)

^a Six patients submitted samples from two households

Falkinham. Emerg Infect Dis In Press (March 2011)

NTM Fingerprint Comparisons



Samples Collected and NTM-Recovery Correlated

- Households sampled 43
- Total household samples 383
- Average samples/household 8.9
- Range 2 - 26
- Correlation coefficient (r) 0.45

Falkinham. Emerg Infect Dis In Press (March 2011)

Households Can Have Multiple NTM Species

- Households > 1 NTM 45 % (10/22)
- Samples > 1 NTM 20 % (77/383)
- Range NTM/household 1 – 5 (1.9/household)

Falkinham. Emerg Infect Dis In Press (March 2011)

Hot Water Heater Temperature is a Determinant of NTM Presence

Hot Water Heater Temperature	NTM ⁺	NTM ⁻	Total
≤ 125° F (50° C)	17	3	20
≥ 130° F (55° C)	6	9	15
Total	23	12	35

P = 0.0107; Relative Risk = 2.125; Fisher's Exact Test

Falkinham. Emerg Infect Dis In Press (March 2011)

Water Source Influences NTM Presence in Households

Water Source	NTM⁺	NTM⁻	Total
Public	19 (70 %)	8	27
Well	5	7 (58 %)	12
Total	24	15	39

P = 0.1532; Relative Risk = 1.689; Fisher's Exact Test

Falkinham. Emerg Infect Dis In Press (March 2011)

Current Projects

- **Why do Some Households Lack NTM?**
Plumbing characteristics or resident microflora?
- **Household Water Filters**
Can filters reduce NTM exposure?
Do NTM grow in granular activated charcoal (GAC) filters?
- **NTM Biofilms**
Adherence and biofilm formation on surfaces
Are NTM biofilm pioneers?

Questions

- What is the role of environment and host in governing susceptibility to NTM?
- What is the most informative method for fingerprinting NTM (e.g., PFGE, *rep*-PCR, IS-RFLP, MLS)?
- What is the clonal variability of NTM in household plumbing and patients?