

# Legionnaire's Disease Cluster: Impact of Stream Microbial Ecology on Community Health

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# Legionellosis

- Legionella bacteria, esp. *L. pneumophila* can cause pneumonia or flu-like Pontiac fever; mild cases rarely diagnosed
- Wide-spread in water environments
- Illness spread by breathing aerosols with Legionella growing in warm water: showers, outdoor fountains, chillers & cooling towers; not person-to-person
- Incubation time: 2-14 days after exposure

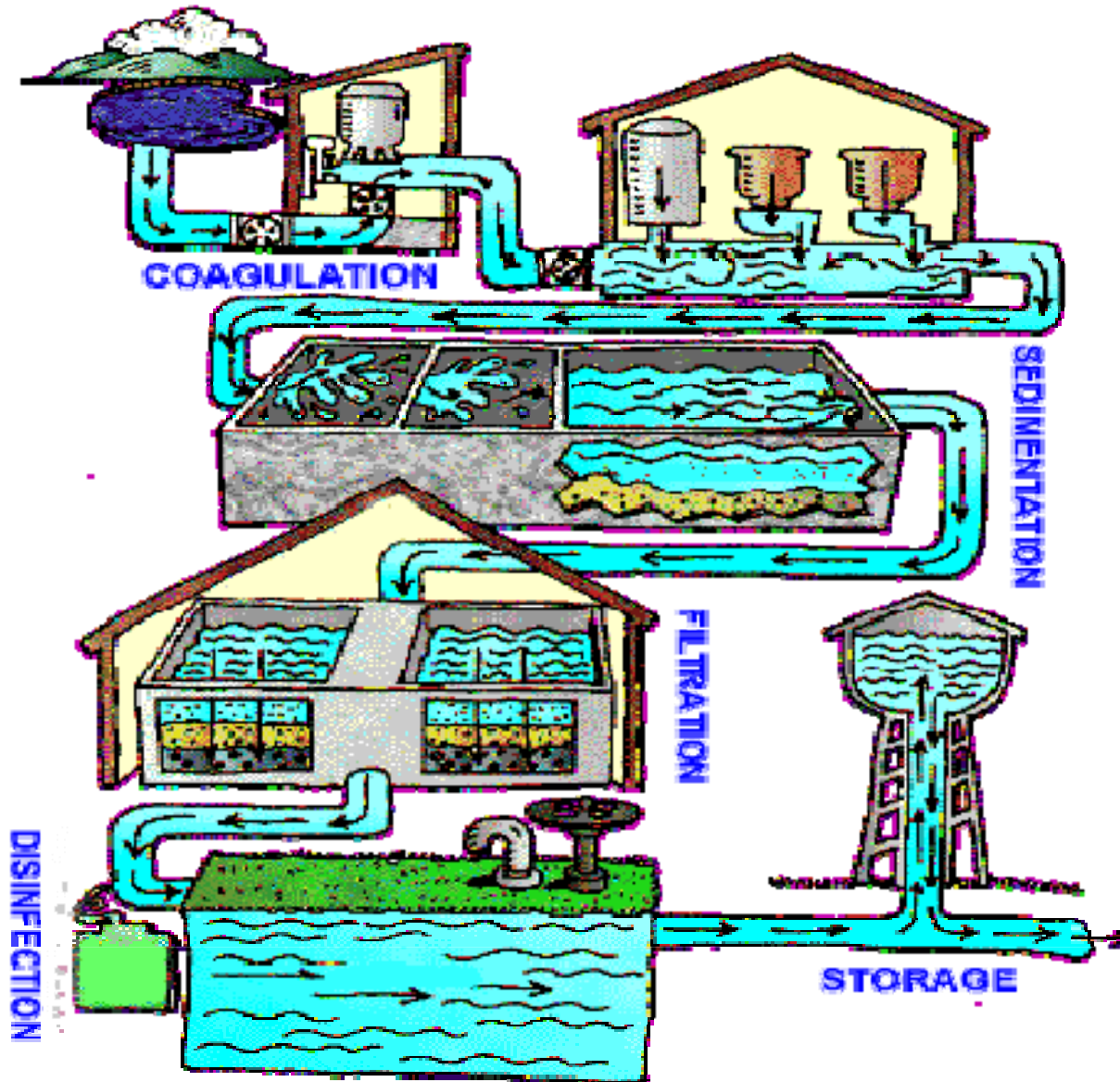
# Legionellosis, cont.

- Reportable disease: 8-18 K U.S. cases/yr
- Primarily affects immunocompromised, elderly, alcoholics, smokers, and those with diabetes, kidney failure & COPD
- 95% diagnoses in patients hospitalized for pneumonia; urine antigen for Lp type 1
- Missed cases: 10-20% other species or serotypes; most Pontiac Fever cases due to different disease mechanism & severity

# Legionellosis, cont.

- Best growth at 95-105° F (35-40° C)
- Killing requires ~160° F (~70° C)
- Water heaters set low need to be set higher; scalding risk addressed by mixing valve in bathroom
- In buildings: copper-silver ion generator or chlorine dioxide generator in addition to residual chlorine from treatment plant

# Water System Processes



# Source of Legionella in the Water Environment

- Widespread in ambient surface waters, but streams & waterfalls not linked to outbreaks
- Complex ecology: both free and trapped in various amoeba species and/or biofilm (microorganisms embedded in their secretions on a surface)
- ↑ virulence after residing in amoeba: commensal existence vs digestion
- Higher incidence with heat, rain & humidity

# Legionella and Water Treatment

- Vegetative amoebae and Legionella sensitive to chlorine, but more resistant than GI pathogens
- Amoebae can form hardy cysts which have high resistance to chlorine
- Trapped Legionella inside amoeba cysts and/or biofilm are also very resistant
- Some Legionella survive water treatment inside amoeba cysts: can be found in various treatment steps, e.g., filter beds

# Controlling Legionella

- WHO supports 0.2 – 0.5 ppm free chlorine residual for hotels, hospitals and ships
- Works by inhibiting growth of Legionella and amoebae
- 1 – 2 ppm (or more) free chlorine residual can kill free Legionella and most amoebae
- 10 – 50 ppm free chlorine residual needed if Legionella is in biofilm or amoeba cyst
- Thermal treatment  $>60^{\circ}$  C for 5 minutes



# How to Grow Legionella in the Distribution System

- Provide warm water with nutrients
  - Streams typically 25 - 35° C in summer
- Use up the chlorine residual
  - React chlorine with increased organic material
  - Warm tanks in the summer, esp. with the same pipe in and out
  - Allow build-up of sediment in pipes, which also reacts with chlorine
- Do not disturb biofilm in water mains

# Proving the Water Link

- Legionella not always present in water samples due to sporadic releases of biofilm from pipe and tank
- Fastidious in culture test, often requiring 5 – 10 days or more, so clinical use of urine antigen test for *L. pneumophila*, serotype 1 (80-90% of hospitalized cases)

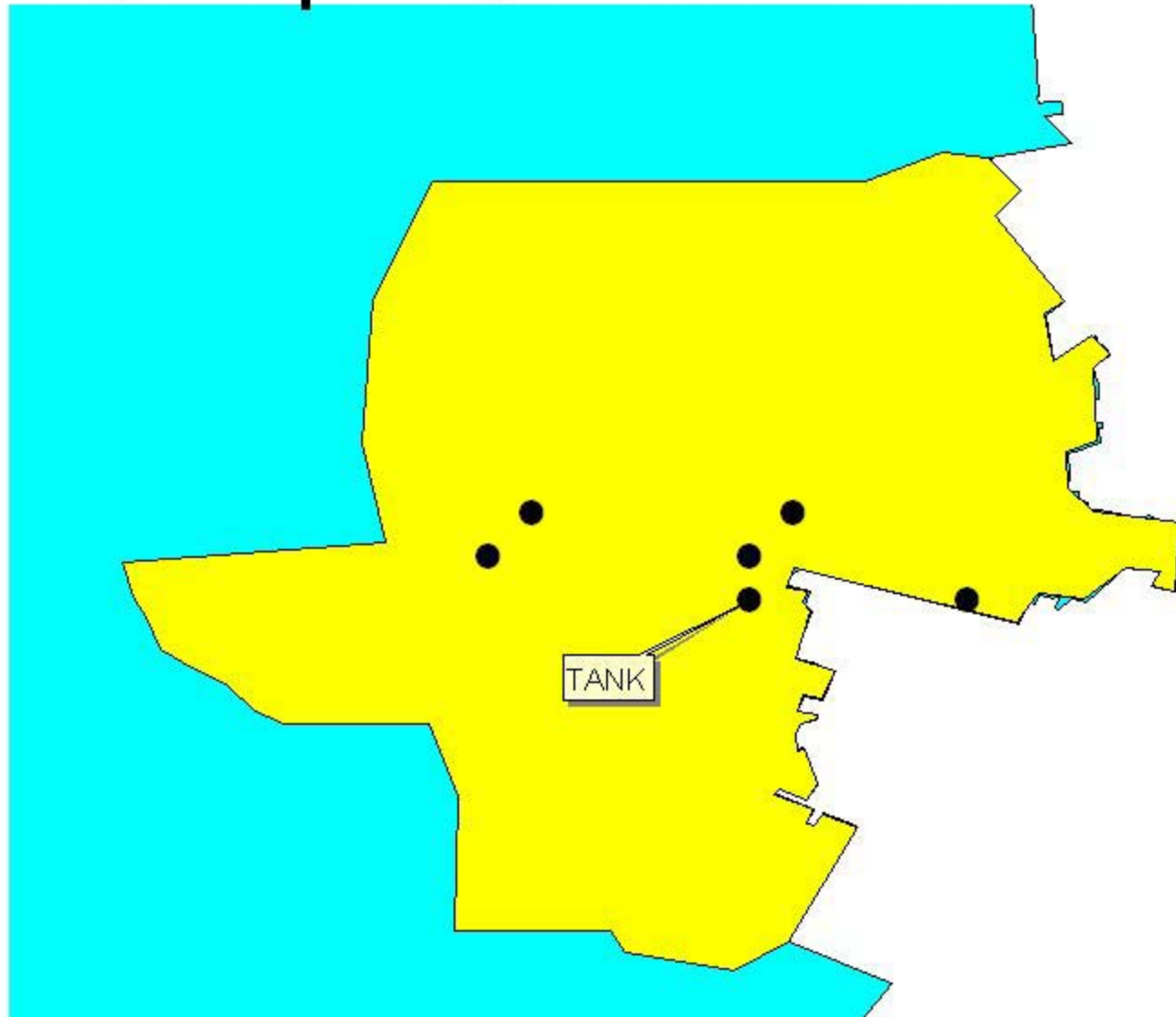
# Investigation of a Case Cluster

- During 2003 – 2007 10 cases clustered around an elevated storage tank in system using water from a river
- Follow-up analysis spanned 2003 – 2010
- 17 cases, 16 were 50+ yr olds
- Cases spread through community, different types of housing
- Most cases in the late summer/early fall
- No ID'd chiller units as alternative routes

# Investigation..., cont.

- Normal treatment plant operation
- Low residual chlorine  $<0.2$  ppm during warm weather in 5 sites routinely tested in the investigation area, but total coliform & E. coli bacteria were not an issue
- Appropriate residual chlorine levels during warm weather in most of the rest of the distribution system

# Investigation Area Sample Sites and Tank



# Annual Occurrence Rates, 50 + year olds, 1/2003 - 9/2010

	Cases	Population, 50+ yrs old	Annual rate per 100,000
Water System Srcv Area	41	46,950	11
Investigation Area	16	43,282	56
Remainder of Srcv Area	25	3,668	7.5

# Remediation Suggestions

- Clean mains by flushing or “pigging”
- Empty tank and remove biofilm
- 1-2 ppm residual chlorine during the first months
- Maintain at least 0.2 – 0.5 ppm afterward
- Increase chlorine residual test frequency and sites in the area during warm weather months in the first yrs of operation

# Conclusions

- Controlling fecal pathogens is not sufficient for controlling pathogens sequestered in amoeba cysts and biofilm
- There are other respiratory pathogens that escape by similar mechanism
- Systems using surface water must manage their distribution systems knowing that higher temperatures and nutrient levels promote biofilm growth and depletion of chlorine residual



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