

# Legionella in healthcare: a hidden risk

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The Netherlands



# Bovenkarspel 1999

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## Executive Summary


Health Council of the Netherlands. Controlling Legionnaire's Disease. The Hague: Health Council of the Netherlands, 2003; publication no. 2003/12.

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Following the 1999 epidemic of *Legionella pneumonia* which broke out among visitors to the West-Friese Flora in Bovenkarspel, the Minister of Health, Welfare and Sport has approached the Health Council for advice. The Minister wanted to know how prevention could be improved and how gains might be made from the improved diagnosis and treatment of patients suffering from Legionnaire's Disease. Building on a previous advisory report completed in 1986, the Committee on Legionellosis addresses these questions in the present report. Its ability to provide concrete answers is of course subject to the limitations of the scientific situation.



De Gezondheidsraad is lid van het International Network of Agencies for Health Technology Assessment (INAHTA). INAHTA bevordert de uitwisseling en samenwerking tussen de leden van het netwerk.

A person in a dark wetsuit is seen from behind, paddling a surfboard towards a large, dark, and turbulent wave. The wave is massive and appears to be breaking, creating a sense of danger and risk. The sky is overcast and grey, adding to the somber and hazardous atmosphere of the scene. The water is dark and choppy, with white foam visible at the base of the wave.

**Water can be a risk !**  
(or better what's in it)

# Background

- 56<sup>th</sup> American Legion Convention 1976
- Philadelphia, Bell Vue Stratford hotel
- 182 cases with 29 deaths
- Discovered by Dr McDade
- Bacteria common in water and soil

Philadelphia, Pa. Hotel Bellvue-Stratford.





# The genus *Legionella*

*Legionella pneumophila*

*Legionella longbeachae*

*Legionella micdadei*

*Legionella anisa*

*Legionella hackeliae*

*Legionella dumoffii*

*Legionella gratiana* ..... 57 species

...Legionnaires' disease or legionellosis

# Do all of them cause disease?

***Legionella pneumophila***

***Legionella longbeachae***

***Legionella micdadei***

***Legionella anisa***

***Legionella hackeliae***

***Legionella dumoffii***

***Legionella gratiana*** ..... 57 species

**...Legionnaires' disease or legionellosis**



# Epidemiology of *Legionella* spp.

24 species have been at least once isolated from humans, but....

*Legionella pneumophila* : ~ 91% of the cases worldwide

*Legionella longbeachae* : ~ 5% of the cases worldwide

*Legionella micdadei* : ~ 2% of the cases worldwide

(Yu *et al.*, J. infect. Dis. 186:127-128)

*Legionella longbeachae* : ~ 30% of the cases in Australia and New Zealand  
nearly 50% of the cases in South Australia

(Yu *et al.*, J. infect. Dis. 186:127-128)

*L. pneumophila* is clearly predominant in human infection  
followed by *L. longbeachae*

# *Legionella pneumophila*

*Legionella pneumophila* :

...there are 15 serogroups (Sg) within the species *L. pneumophila*

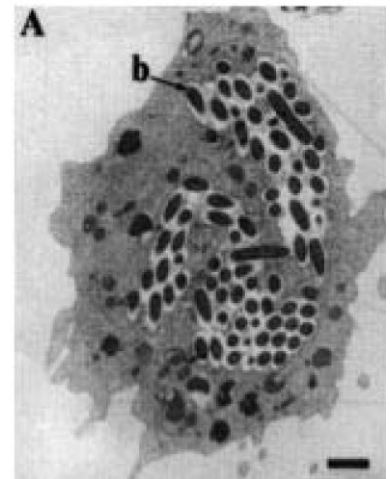
*Legionella pneumophila* Sg1: ~ 88,6% of legionellosis cases  
caused by *L. pneumophila*

**L. pneumophila Sg 1 seems to be more virulent for humans  
→ Detection in patients & environment important !**



# Sources of *Legionella*

- ⦿ *Legionella* can be found in natural, freshwater environments, but they are present in insufficient numbers to cause disease.
- ⦿ Potable (drinking) water systems, whirlpool spas, and cooling towers provide the 3 conditions needed for *Legionella* transmission
  - ✧ heat - stasis – aerosolization
- ⦿ Ecological niche
  - ✧ Free-living amoebae and protozoa in water



# How legionella multiplies

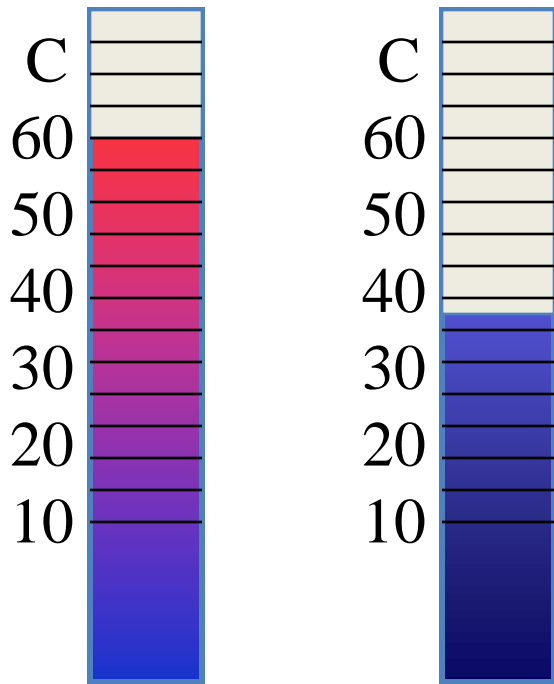
- ⦿ Favourable pH & temperature
- ⦿ Ideal is 37°C (human body)
- ⦿ Stagnation provides time for multiplication
- ⦿ Key nutrients are free iron & L cysteine
- ⦿ Biofilm protection

# *Legionella* in the Environment

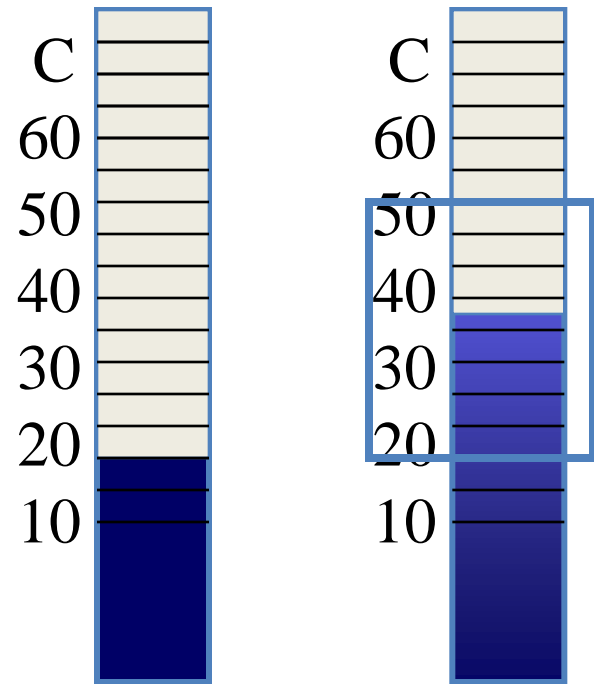
- ◎ The bacteria grow best in warm water 25-50°C, like the kind found in:
  - ✧ Hot tubs
  - ✧ Cooling towers
  - ✧ Hot water tanks
  - ✧ Large plumbing systems
  - ✧ Decorative fountains

# Legionella & temperature - two problems!

**Hot water**



**Cold water**





# Hot and cold water systems



Cause the most cases !

# Infection routes

- © Ingestion
- © Contact (particularly relevant for wound care)
- © Inhaling aerosols



# Spread of Disease

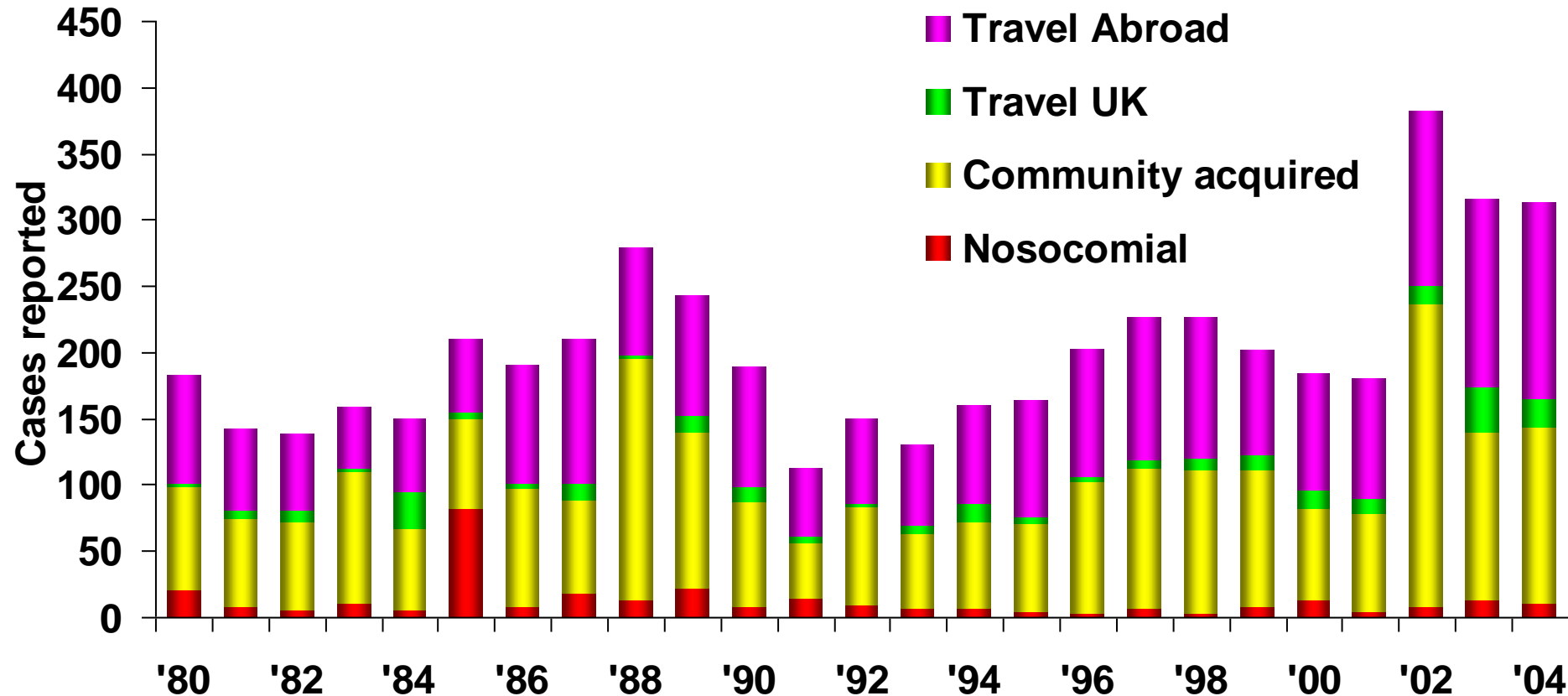
- ⦿ People get Legionnaires' disease when they breathe in a mist or vapor containing Legionella.
  - ✧ e.g. breathing in droplets sprayed from a hot tub that has not been properly cleaned and disinfected
  - ✧ contaminated shower
- ⦿ Legionella does **not** spread from one person to another person.

# Frequency of Legionnaires' Disease

- ⦿ Each year an estimated 8,000-18,000 hospitalized cases occur in the U.S. However, accurate data reflecting the true incidence of disease are not available because of under-utilization of diagnostic testing and under-reporting.
- ⦿ Travel-associated outbreaks, outbreaks in community settings, and healthcare and occupational outbreaks are common.



# Legionnaires' disease in residents of England and Wales by category of exposure 1980-2004



# Epidemiologic risk factors for Legionellosis

- ⦿ Recent travel with an overnight stay outside of the home
- ⦿ Exposure to whirlpool spas
- ⦿ Recent repairs or maintenance work on domestic plumbing
- ⦿ Renal or hepatic failure
- ⦿ Diabetes
- ⦿ Systemic malignancy
- ⦿ Smoking
- ⦿ Immune system disorders
- ⦿ Age > 50 years

# Legionella - how much is too much

⊙ Infectious dose is unknown !

1<sup>st</sup> legal breakpoint  
for the NL: 50 cfu/l

- ✧ Susceptible animals  $10^3$  CFU/l
- ✧ Immunocompromised patients  $3-8 \times 10^3$  CFU/l
- ✧ Healthy adult  $10^5 - 10^9$  CFU/l

# When is Legionella a risk?

Aerobic heterotrophic count CFU/ml	Action required
< 100 CFU/L	Acceptable control. No remedial action required.
100 – 1000 CFU/L	Review programme operation. The count should be confirmed by immediate resampling. If a similar count is found again, a review of the control measures and risk assessment should be carried out to identify remedial actions.
> 1000 CFU/L	Implement corrective action (action to be taken when the results of monitoring at the control point indicate a loss of control). The system should immediately be resampled. It should then be “shot dosed” with an appropriate biocide, as a precaution. The risk assessment and control measures should be reviewed to identify remedial actions.

# Signs & Symptoms

- ⦿ Symptoms like many other forms of pneumonia.
- ⦿ **Signs of Legionnaires' disease** can include:
  - ✧ Cough
  - ✧ Shortness of breath
  - ✧ High fever
  - ✧ Muscle aches
  - ✧ Headaches
- ⦿ These symptoms usually begin 2 to 14 days after being exposed to the bacteria.

# Susceptibility of Individuals

- ⦿ Increasing age, especially over 45
- ⦿ Gender; men
- ⦿ Smokers, alcoholics
- ⦿ Chronic respiratory or kidney disease
- ⦿ Diabetics, cancer sufferers



# Pontiac Fever

- ⦿ A milder infection, also caused by *Legionella* spp, is called Pontiac fever.
- ⦿ The **symptoms of Pontiac fever** are similar to those of Legionnaires' disease and usually last for 2 to 5 days.
- ⦿ Pontiac fever is different from Legionnaires' disease because the patient does not have pneumonia.
- ⦿ Symptoms go away on their own without treatment.

# Clinical Diagnosis of Legionellosis

	Legionnaires' disease	Pontiac fever
<b>Clinical features</b>	Pneumonia, cough, fever	Flu-like illness (fever, chills, malaise) without pneumonia
<b>Radiographic pneumonia</b>	Yes	No
<b>Incubation period</b>	2-14 days after exposure	24-72 hours after exposure
<b>Etiologic agent</b>	<i>Legionella</i> species	<i>Legionella</i> species
<b>Attack rate</b> <a href="#">[1]</a>	< 5%	> 90%
<b>Isolation of organism</b>	Possible	Never
<b>Outcome</b>	Hospitalization common Case-fatality rate: 5-30% <a href="#">[2]</a>	Hospitalization uncommon Case-fatality rate: 0%

# Treatment & Complications

- ⦿ Legionnaires' disease requires treatment with antibiotics (macrolides, quinolones)
- ⦿ Previously healthy people usually get better after being sick with Legionnaires' disease, but hospitalization is often required.
- ⦿ Possible Complications
  - ✧ Lung failure
  - ✧ Death (5-30%)

# A Worldwide Perspective of Atypical Pathogens in Community-acquired Pneumonia

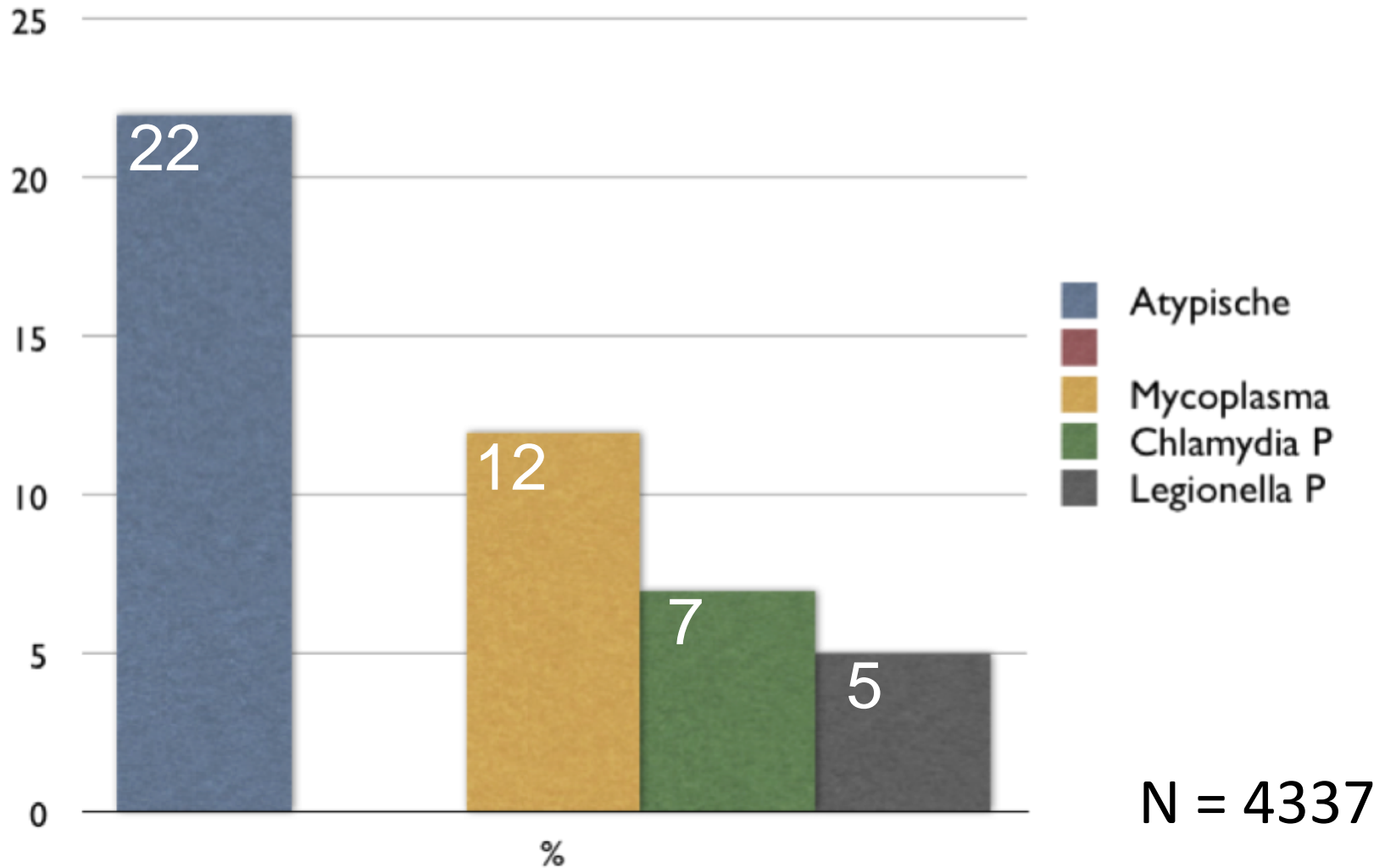
Forest W. Arnold<sup>1</sup>, James T. Summersgill<sup>1</sup>, Andrew S. LaJole<sup>1,2</sup>, Paula Peyrani<sup>1</sup>, Thomas J. Marrie<sup>3</sup>, Paolo Rossi<sup>4</sup>, Francesco Blasi<sup>5</sup>, Patricia Fernandez<sup>6</sup>, Thomas M. File, Jr.<sup>7</sup>, Jordi Rello<sup>8</sup>, Rosario Menendez<sup>9</sup>, Lucia Marzoratti<sup>10</sup>, Carlos M. Luna<sup>11</sup>, Julio A. Ramirez<sup>1</sup>, and the Community-Acquired Pneumonia Organization (CAPO) Investigators\*

<sup>1</sup>Division of Infectious Diseases, Department of Medicine, and <sup>2</sup>Department of Health Promotion and Behavioral Sciences, University of Louisville, Louisville, Kentucky; <sup>3</sup>University of Alberta Hospital, Sturgeon Community Hospital, Grey Nuns Hospital, and Royal Alexandra Hospital, Edmonton, Alberta, Canada; <sup>4</sup>Department of Medicine, S. Maria della Misericordia Hospital, Udine, Italy; <sup>5</sup>Istituto Malattie Respiratorie, University of Milan, Istituto di Ricerca e Cura a Carattere Scientifico, Policlinico, Milan, Italy; <sup>6</sup>Instituto Nacional del Torax, Santiago, Chile; <sup>7</sup>Summa Health System, Akron, Ohio; <sup>8</sup>Joan XXIII University Hospital, Tarragona, Spain; <sup>9</sup>Hospital Universitario La Fe, Valencia, Spain; <sup>10</sup>Sanatorio 9 de Julio, Tucuman, Argentina; and <sup>11</sup>Hospital de Clinicas, Buenos Aires, Argentina

## ***Aim:***

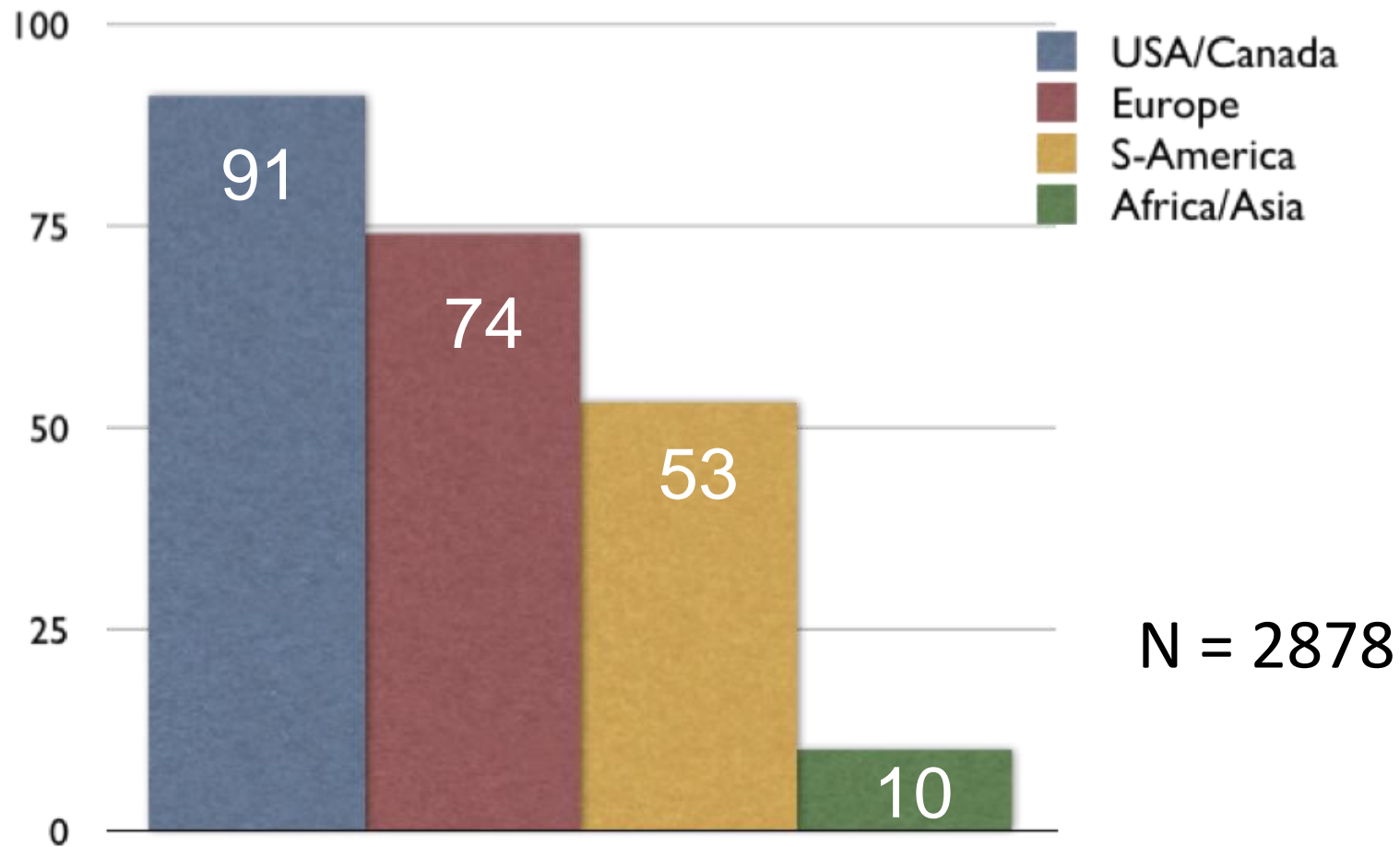
1. Prevalence of atypical pathogens
2. Outcome empiric treatment

# Incidence of atypical pathogens in CAP

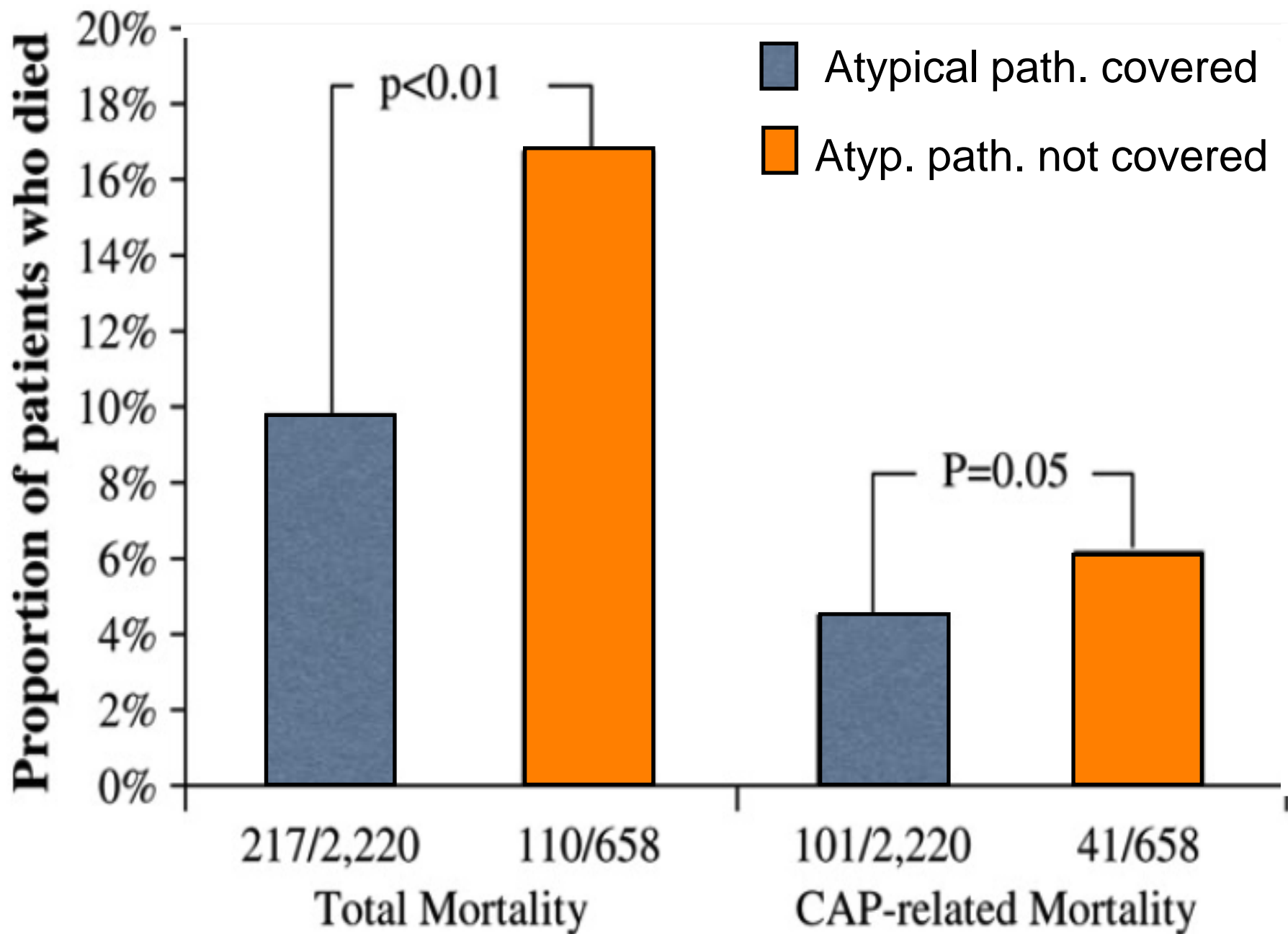


Arnold, *Am J Respir Crit Care Med*, 2007

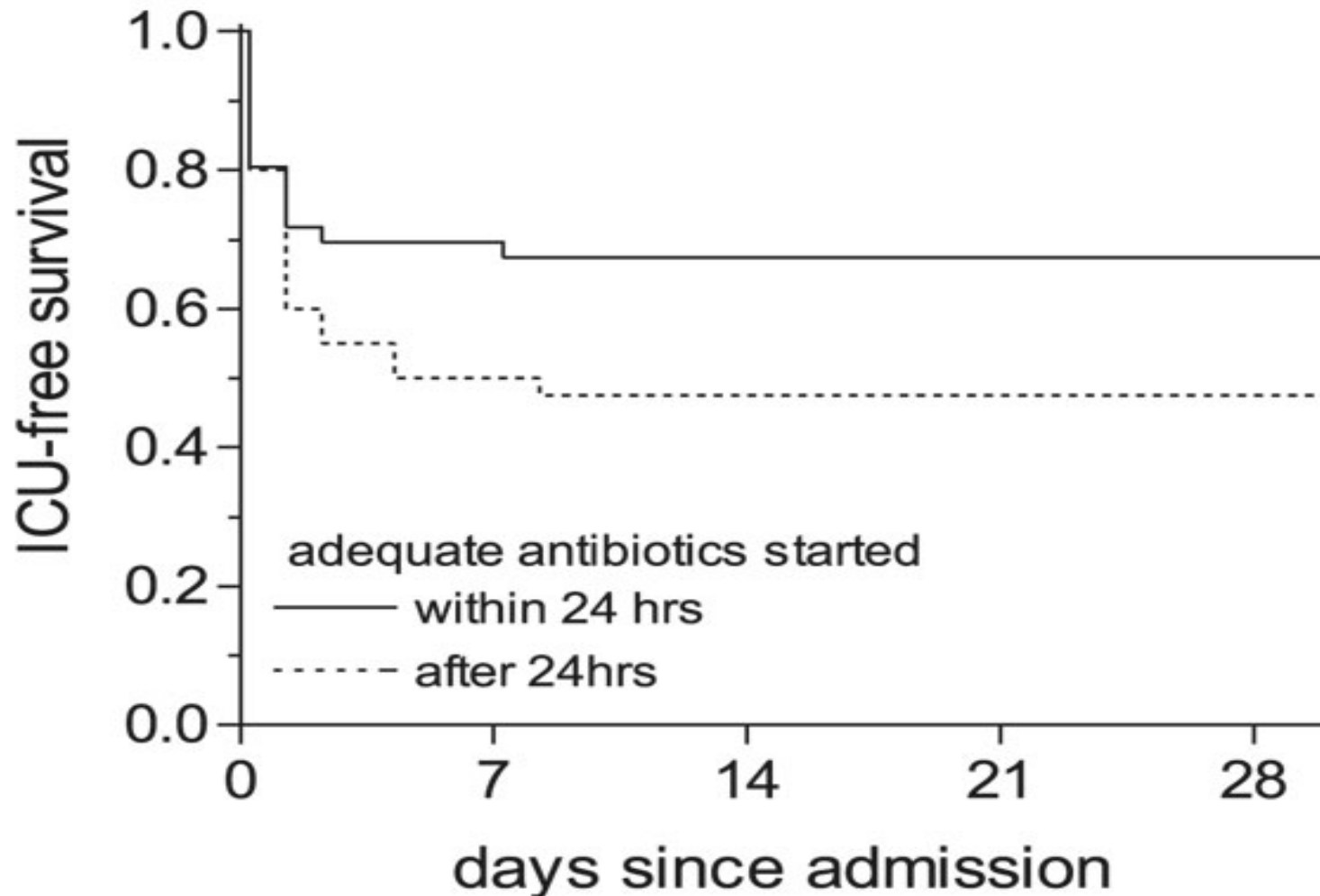
# Empiric treatment includes atypical pathogens in guideline







# Legionella CAP mortality



# Who to Test for Legionnaires' Disease

- ⦿ Patients who have failed outpatient antibiotic therapy
- ⦿ Patients with severe pneumonia, in particular those requiring intensive care
- ⦿ Immunocompromised host with pneumonia
- ⦿ Patients with pneumonia in the setting of a legionellosis outbreak
- ⦿ Patients with a travel history [Patients that have traveled away from their home within two weeks before the onset of illness.]
- ⦿ (Patients suspected of healthcare-associated pneumonia)

# Diagnostic

- ⦿ Currently available diagnostic tests include detection of *Legionella* spp. by
  - ✧ Serology
  - ✧ Culture or PCR in respiratory samples
  - ✧ *Legionella pneumophila* antigen testing in urine
- ⦿ Tests lack sensitivity, urine antigen test only identifies *Legionella pneumophila* serogroup 1

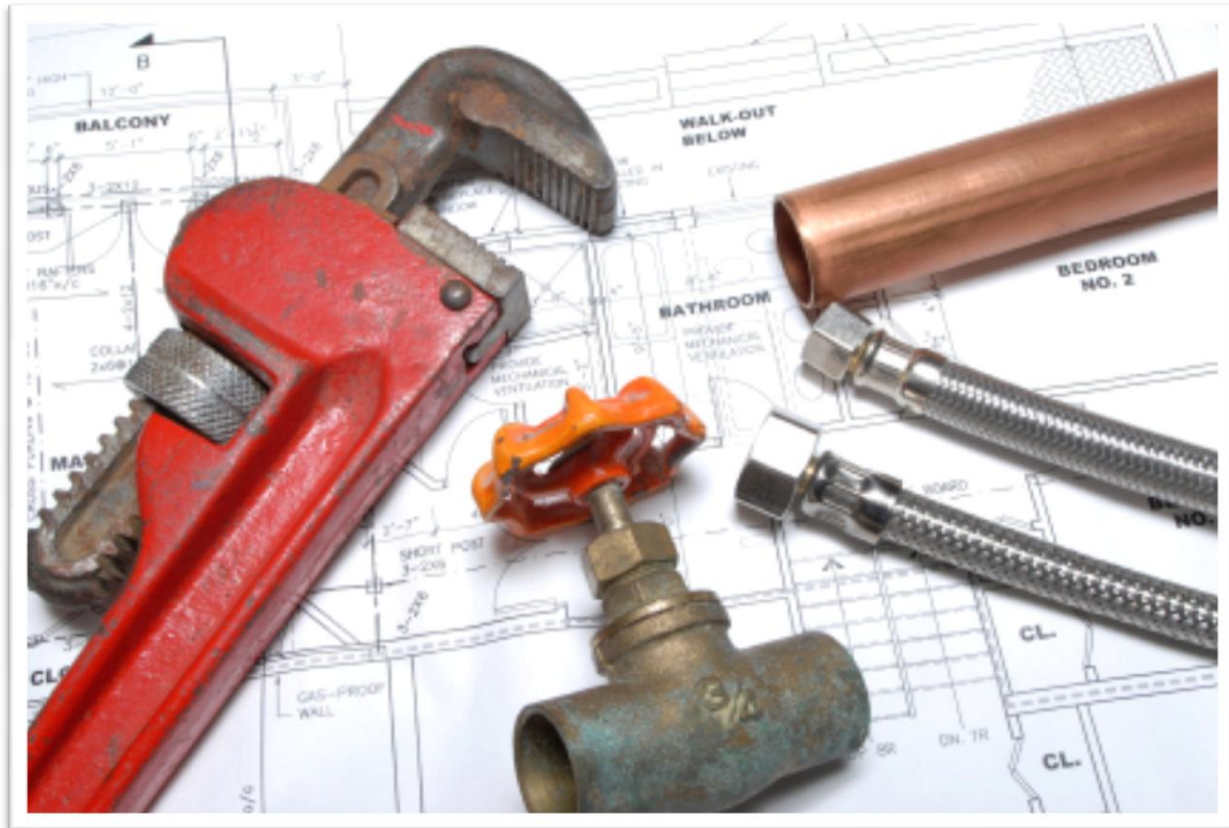


# How to Test for Legionnaires' Disease

Test	Sensitivity (%)	Specificity (%)
Culture	20-80	100
Urine antigen	70-100	100
Paired serology	80-90	>99
Direct fluorescent antibody stain	25-75	≥95
PCR	unknown	unknown

# Prevention of Legionella

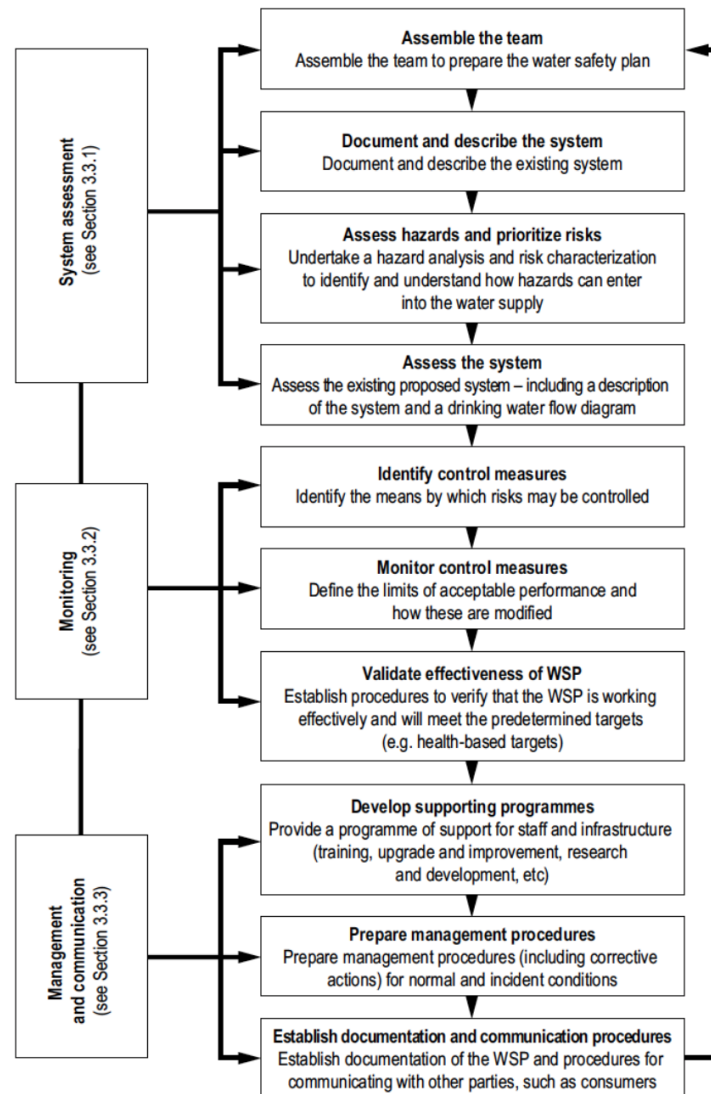
- ⦿ Not a job for infection control, but for those building, maintaining and controlling water systems



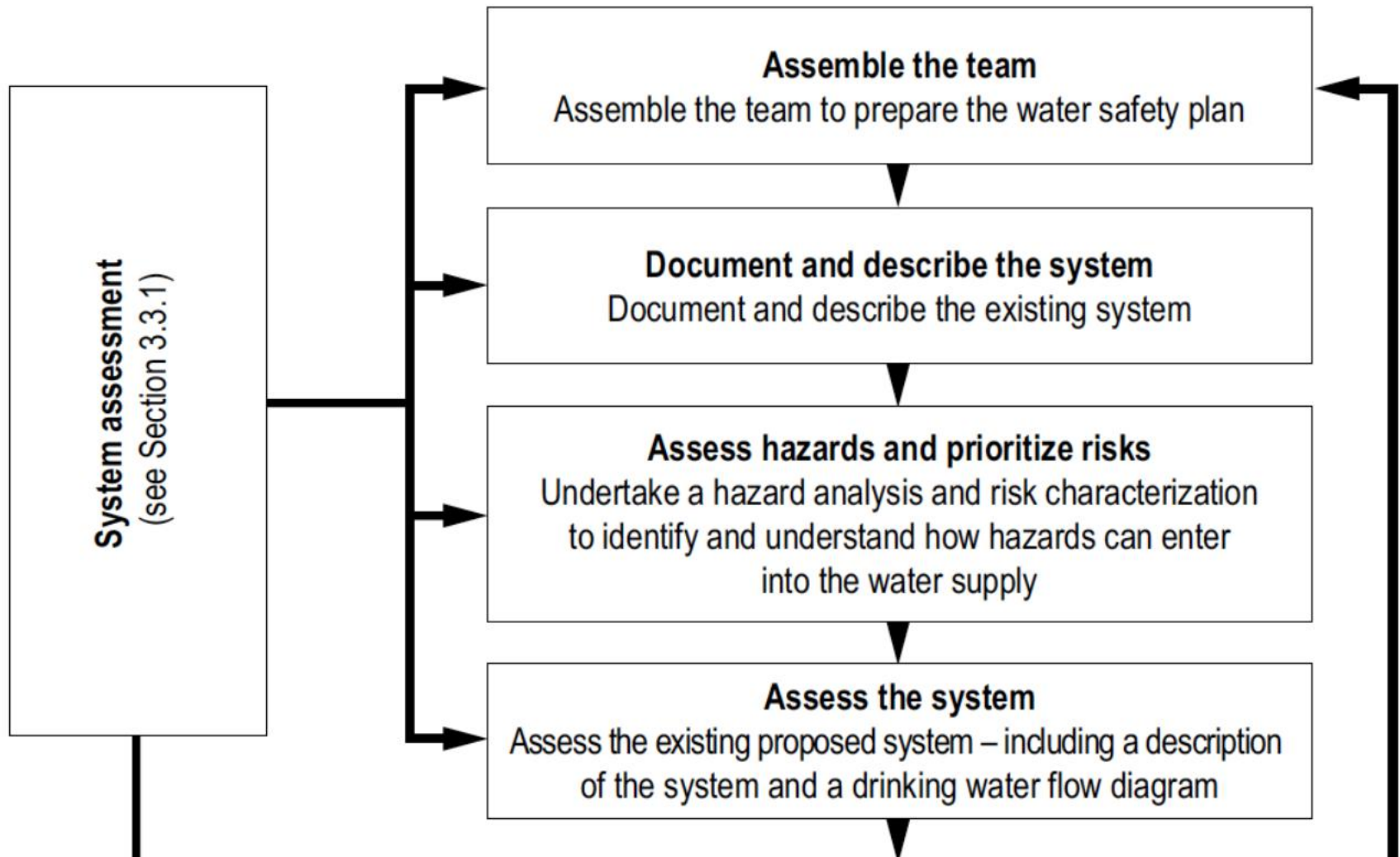
# Prevention: Health-care facilities

- ⦿ Surveillance data on nosocomial Legionnaires' disease
- ⦿ Water safety plan overview
- ⦿ System assessment
  - ✧ Document and describe the system
  - ✧ Assess hazards and prioritize risks
- ⦿ Monitoring
  - ✧ Identify control measures
  - ✧ Monitor control measures
- ⦿ Management and communication
  - ✧ Prepare management procedures
  - ✧ Establish documentation and communication procedures

# Water Safety Plans

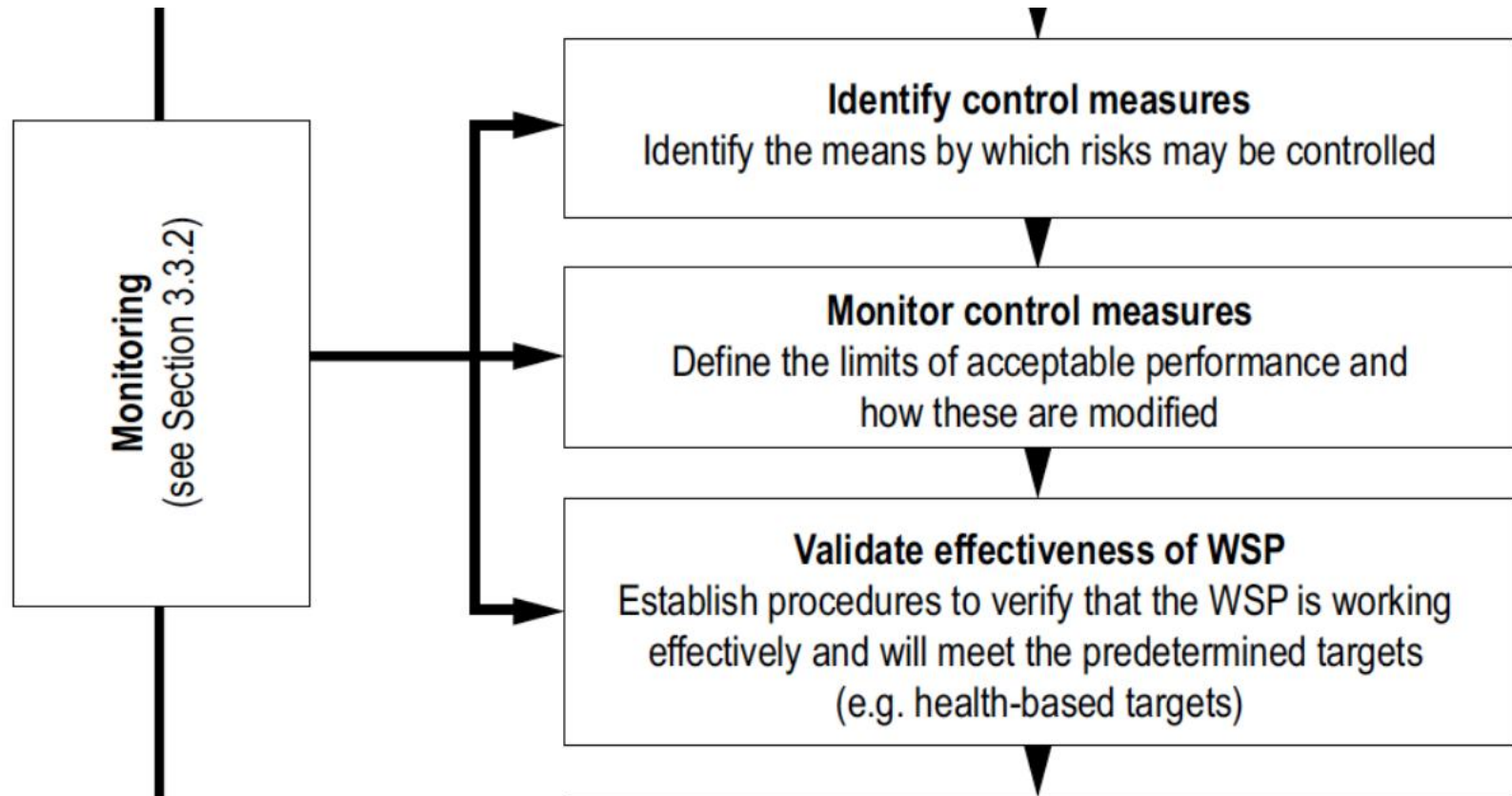


# Water Safety Plans

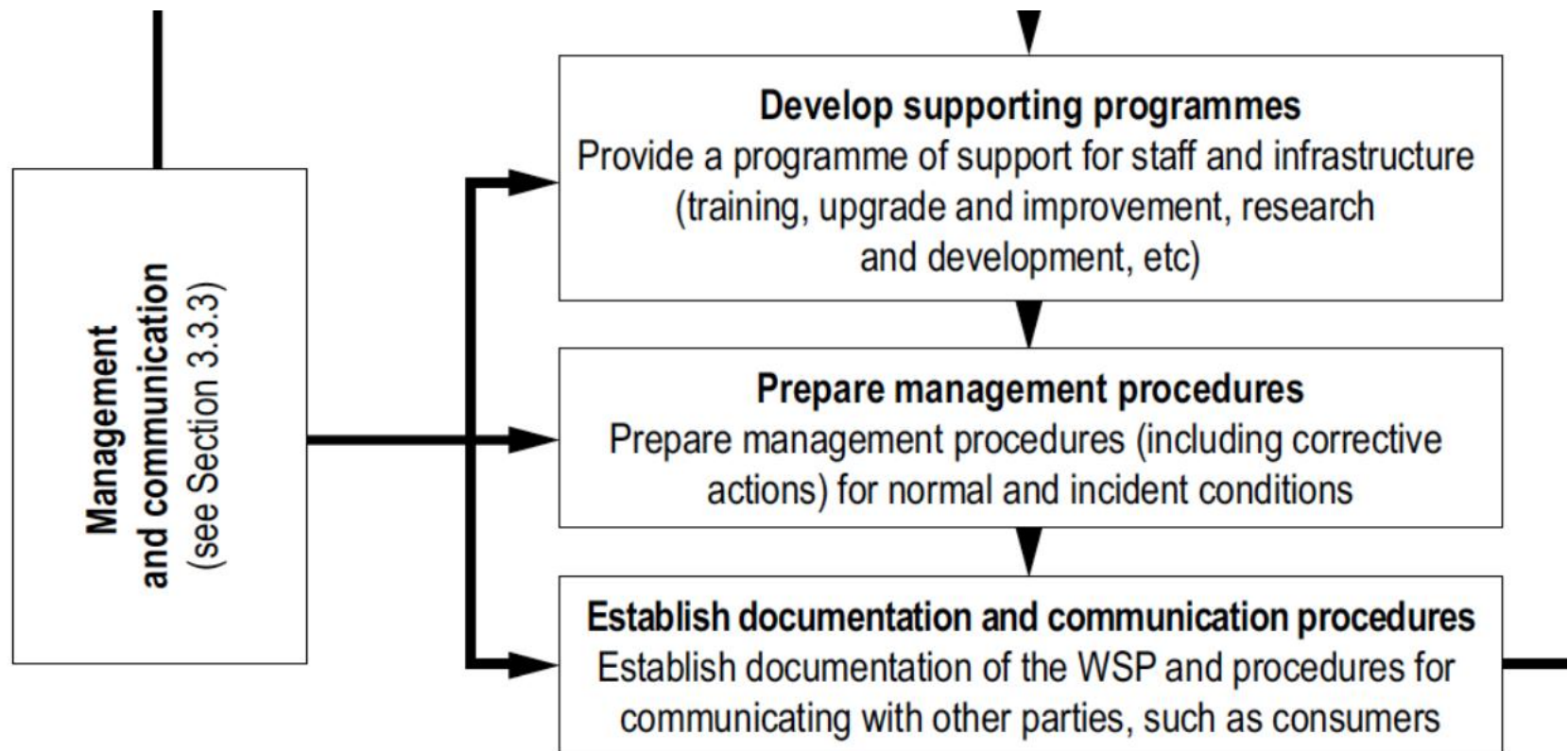




# Water Safety Plans



# Water Safety Plans



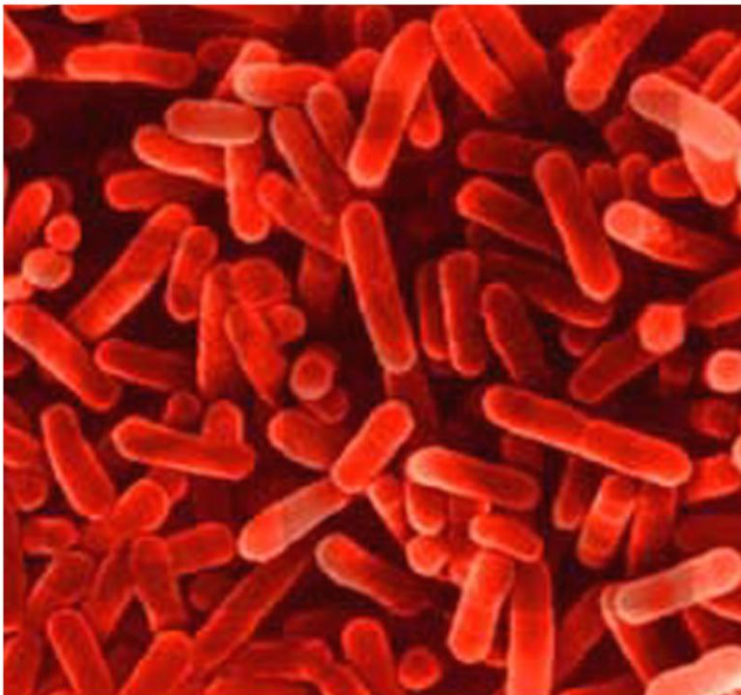
# Water Systems checks

- ⦿ Weekly - flushing little used outlets
- ⦿ Monthly – temperature checks
- ⦿ Quarterly - shower cleaning
- ⦿ Six monthly - CWS Tank temperatures
- ⦿ Annually - CWS Tank inspections, calorifier checks
- ⦿ Other systems as required

# Appropriate Records

- ⦿ Responsible persons
- ⦿ Significant findings of the risk assessment
- ⦿ Written scheme of actions and control measures
- ⦿ Results of any monitoring, inspection, test or check carried out

# Nosocomial infections





# Risk factors for Legionella infection

	Community acquired	Travel associated	Nosocomial
<b>Modes of transmission</b>	Inhalation of contaminated aerosol <sup>a</sup>	Inhalation of contaminated aerosol	Inhalation of contaminated aerosol, aspiration, wound infection
<b>Sources of Legionella</b>	Cooling towers; hot and cold-water systems; spa pools, thermal pools, springs; humidifiers; domestic plumbing; potting mixes and compost	Cooling towers; hot and cold-water systems; spa pools, thermal springs and pools; humidifiers	Cooling towers; hot and cold-water systems; spa pools, natural pools, thermal springs; respiratory therapy equipment; medical treatment
<b>Reservoir of Legionella</b>	Industrial sites, shopping centres, restaurants, clubs, leisure centres, sports clubs, private residences	Hotels, cruise ships, camp sites, shopping centres, restaurants, clubs, leisure centres, sports clubs	Hospitals, medical equipment
<b>Risk factors (environmental)</b>	Proximity to sources of transmission, poor design or poor maintenance of cooling water systems, inadequate staff training	Stay in accommodation designed for short stays and seasonal use; intermittent room occupancy and water use; intermittent water supply and fluctuating water temperature control; complex water systems; lack of trained staff to manage water systems	Complex water distribution system, long pipe runs, poor water temperature control, low water flow rates



# Control methods (1)

Method	Advantages	Disadvantages
Keeping temperature <20 °C	<ul style="list-style-type: none"><li>• Simple, effective and easily monitored</li><li>• Little significant growth of <i>Legionella</i></li></ul>	<ul style="list-style-type: none"><li>• Only really applicable to drinking water systems</li></ul>
Keeping temperature >50 °C	<ul style="list-style-type: none"><li>• Simple, effective and easily monitored</li></ul>	<ul style="list-style-type: none"><li>• Does not eliminate legionellae</li><li>• Requires circulation temperature to be near 60 °C</li><li>• Difficult to maintain temperatures in old systems</li><li>• Requires protection against scalding</li></ul>
Periodic flushing with hot water at 50–60 °C (usually an essential part of control by high temperature, above)	<ul style="list-style-type: none"><li>• Simple, effective and easy to monitor</li></ul>	<ul style="list-style-type: none"><li>• Not applicable in cold-water systems</li><li>• Requires protection against scalding</li><li>• Must be maintained and inspected to achieve consistent control</li><li>• Recolonization occurs within days</li></ul>

Shunt it !

cold-water

hot-water

# **LEGIONELLA**

## **and the prevention of legionellosis**

WHO Library Cataloguing-in-Publication Data

World Health Organization

*Legionella* and the prevention of legionellosis

1. *Legionella* 2. Legionellosis — prevention and control 3. Legionnaires' disease — prevention and control 4. Water supply 5. Swimming pools 6. Health facilities 7. Ships 8. Disease outbreaks — prevention and control I. Title

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# Control methods (2)

Dosing with sodium hypochlorite	<ul style="list-style-type: none"> <li>• Proven, effective disinfection technique</li> <li>• Simple to use</li> <li>• Relatively cheap</li> </ul>	<ul style="list-style-type: none"> <li>• Formation of trihalomethanes</li> <li>• Needs protection (e.g. carbon filter) for dialysis patients</li> <li>• Toxic to fish</li> <li>• Affects taste and odour</li> <li>• Not stable, particularly in hot water</li> <li>• Increases corrosion of copper</li> </ul>
Dosing with monochloramine	<ul style="list-style-type: none"> <li>• More persistent than chlorine</li> <li>• Simple to use in mains distributions</li> <li>• Penetrates into biofilms</li> </ul>	<ul style="list-style-type: none"> <li>• Needs protection (e.g. carbon filter) for dialysis patients</li> <li>• Toxic to fish</li> <li>• Affects rubber components</li> <li>• No commercial kit available for dosing small water systems</li> </ul>
Dosing with chlorine dioxide	<ul style="list-style-type: none"> <li>• Proven disinfection technique</li> <li>• Simple to use</li> </ul>	<ul style="list-style-type: none"> <li>• Formation of chlorite</li> <li>• Needs protection (e.g. carbon filter) for dialysis patients</li> <li>• Safety considerations (depending on method of generation)</li> </ul>



# Control methods (3)

Method	Advantages	Disadvantages
Dosing with hydrogen peroxide	<ul style="list-style-type: none"><li>• Simple to use</li></ul>	<ul style="list-style-type: none"><li>• Weak disinfectant</li><li>• Suspected of mutagenicity</li></ul>
Copper and silver ionization	<ul style="list-style-type: none"><li>• Effective when prescribed concentrations are maintained</li></ul>	<ul style="list-style-type: none"><li>• Frequent monitoring of copper and silver needed</li><li>• Pretreatment needed (pH, hardness)</li><li>• Increased concentrations of copper and silver in water</li></ul>
Anodic oxidation	<ul style="list-style-type: none"><li>• Disinfection demonstrated</li></ul>	<ul style="list-style-type: none"><li>• Pretreatment needed (depending on effect of pH and hardness)</li><li>• Effect on <i>Legionella</i> in biofilms not known</li></ul>
UV (ultraviolet) disinfection	<ul style="list-style-type: none"><li>• Proven disinfection technique</li><li>• Simple to use</li></ul>	<ul style="list-style-type: none"><li>• Effective only at point of application; no control downstream (no residual)</li><li>• Not suitable for turbid waters</li><li>• No effect on biofilm formation</li></ul>

# Control methods (4)

Point-of-use filters	<ul style="list-style-type: none"> <li>• Physical barrier</li> <li>• Easy to install (may require some modification of the outlet)</li> <li>• Suitable for hot and cold-water systems</li> <li>• Good for use in systems exposing high-risk patients</li> </ul>	<ul style="list-style-type: none"> <li>• Only suitable at point of use</li> <li>• Must be replaced regularly</li> <li>• Particulates in water may reduce flow and operational life</li> <li>• Expensive</li> </ul> <p>Great during outbreaks</p>
Pasteurization heat with flushing	<ul style="list-style-type: none"> <li>• Disinfection barrier</li> <li>• Useful as short-term remedial measure</li> <li>• Simple to apply in hot-water installation</li> </ul>	<ul style="list-style-type: none"> <li>• Transient effect on <i>Legionella</i></li> <li>• No limitation of biofilm formation</li> <li>• Scalding risk</li> </ul>
Non-oxidizing biocides	<ul style="list-style-type: none"> <li>• Proven technique for cooling systems</li> </ul>	<ul style="list-style-type: none"> <li>• Not suitable for potable water systems</li> <li>• Most not applicable to spa pools</li> <li>• Resistant populations may develop</li> <li>• Need to alternate two different biocides</li> <li>• Often concentrations cannot be readily monitored</li> <li>• Difficult to neutralize for sampling purposes</li> </ul>



# Positive culture and now?

- ⦿ No showering (or with bacterial filter\*)
- ⦿ Mineral water to drink
- ⦿ Handwashing and washing of patients using a washcloth is allowed
- ⦿ Inform HCWs and patients  
(including those discharged for at least 3 weeks)
- ⦿ Inform media and health inspection

\* more or less impossible to get and to connect if not anticipated



# Legionella at the UMC St Radboud

- 1989 - cooling towers
- 1992 - hot water too cold (shower/sinks)
- 1995 – hot spot in cold water (shower/sinks)
- 1999 - positive water cultures after construction



# Reconstruction of water system



1999  
Reconstruction of  
C-building UMC

- new hot water source
- new tubing
- removal “dead ends”



**So much about dead ends!**

When the way of monitoring is defeating the purpose !