



## LEGIONELLA DATA SHEET

### BACKGROUND

In his article on perspectives on microbacteriological pathogenic relationships, Cirillo notes that during the evolution of life in our biosphere, endosymbiotic relationships have developed between many protozoa and (for many) their primary food source, prokaryocytes. Over time, the prokaryocyte bacteria *Legionella pneumophila* has been found to replicate intracellularly almost exclusively in macrophages during mammalian infection, and in protozoa in other environments. The pathologic mechanisms required to cause disease in humans have evolved through these billions of years of interactions of bacteria with protozoa. (1) He summarizes the data that suggest that human macrophages have many characteristics in common with free-living amoebae, which produce oxygen radicals (2), undergo an oxidative burst during phagocytosis (3), utilize fusion of lysosomal vacuoles with phagosomes to kill bacteria (4, 5), and have many cell surface receptors in common with macrophages (6-8).

*Legionella pneumophila* grown in amoeba are 10-fold more invasive for macrophages and 100-fold more invasive for epithelial cells than those grown on agar. (9) Replication in macrophage-like cells or in amoebae results in large morphological and biochemical changes and an approximately 1,000-fold increase in resistance to antibiotics and biocides (10) compared with cells grown in conventional media. It seems likely that, in some cases, Legionnaire's disease has resulted from inhalation of aerosols of aggregates of microbial exopolymer or biofilms and amoebae-containing *L. pneumophila*, as well as the historically-presumed free bacteria. (11)

For many bacteria, one stage of possible pelagic bacterial growth is the general stress response (GSR). In this stationary phase, not only are bacteria more virulent, but they are able to survive prolonged periods of nutrient starvation and multiple environmental stresses, such as heat, oxidizing agents and hyperosmolarity. (12) Brown proposes the hypothesis (11) that intracellular and biofilm growth leads to an early GSR, and possibly a more complete expression of the response, relative to that in conventional planktonic culture. He further advances that the co-evolution of bacteria and protozoa has serendipitously equipped some species of bacteria both for environmental survival and for invasion of, and survival in, certain animal cells and tissues.

Protozoa are natural hosts for Legionella, and the survival of the microorganism in both natural and man-made environments, including hospital water systems and moist sanitary areas (13), is dependent on its ability to parasitize its amoebal host. Evidence supports the notion that infection of amoebae and infection of macrophages has a common molecular basis, and the ability of some bacterial species to cause human disease might be a consequence of an evolutionary selection for intracellular growth and survival within environmental protozoa (14, 15).

## **INDUSTRIAL APPLICATIONS**

In practical terms, when one deals with treatment of cooling water systems, the Cooling Technology Institute Guidelines (16) examines three possible scenarios:

- 1.) A low Legionella count with an undetectable or small population of amoebae/protozoa (higher life forms) and low biofilm counts (low sessile bacteria numbers) is a good indication of a clean, well-maintained system with low risk to health.
- 2.) A low bulk water Legionella count along with low numbers of higher life forms in deposits, but with high biofilm counts may indicate a low present health risk but suggests the potential for future problems if steps are not taken to reduce biofilm levels. Since protozoa that promote Legionella amplification graze on bacteria in biofilms, the presence of significant biofilm can promote the development of higher, and thus potentially more dangerous, levels of Legionella.
- 3.) A low bulk water Legionella count associated with a large number of higher life forms indicates a strong potential for amplification, and the low Legionella count cannot therefore be interpreted to indicate a system with a low health risk.

Clearly, then, only a cooling system that has both low bacterial counts and low Legionella counts can be presumed to be truly safe in terms of risk to health.

## **ISSUES REGARDING ROUTINE TESTING**

Routine testing for Legionella has not been recommended (17) for the following reasons:

- 1.) Interpretation of testing results is difficult, depending on the sample site and the test procedure. Legionella may or may not be detected, with resultant liabilities. There are no generally agreed upon levels above which level transmission of the disease is assured or below which level it is not possible.

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- 2.) A clean tower can be rapidly infected shortly after it was shown to be clean.
- 3.) A tower shown to contain Legionella bacteria does not mean that an outbreak of disease will occur. It has been shown that up to 50-60% of all cooling towers test positive for the presence of Legionella bacteria.
- 4.) If an outbreak is suspected, testing specifically for Legionella pneumophila should be performed. Suspected outbreaks should be reported to local or state health departments or to the CDC.

### **RECOMMENDATIONS FOR PREVENTION**

Continuing (17), in terms of prevention, cooling towers should be assessed for routine operation, maintenance, repair, abnormal operation and commissioning. The assessment should include the potential for aerosol formation, the water temperature, the efficiency of drift eliminators, and the effectiveness of the biocide, and the scale and corrosion inhibition program. The more susceptible personnel (elderly, chronically ill, or immune-compromised) in the area, the more critical is the concern.

### **RECOMMENDATIONS REGARDING TREATMENT**

Once an outbreak of Legionella is diagnosed, currently recommended treatment methods for cooling towers and water systems (18, 19), with their advantages and disadvantages, are listed below:

- 1.) Copper and silver ionization works well, is continuous, is cyclic, is controlled by a microprocessor and must be monitored closely for copper and silver ions in the water, and requires electrode replacement frequently. It does seem to treat Legionella in biofilm. It is used in hot water recirculating lines unlikely to be consumed by humans. Costs: \$60,000-100,000 for a hospital, with annual maintenance costs from \$1,500-4,000/year.
- 2.) Hot water flushing works well, is temporary, must be done frequently with monitoring of temperatures during the procedure, and takes a relatively long time to clean out an entire system. For a typical hospital heating units for superheating can run \$36,000-54,000 plus installation and it is fairly labor intensive to run a program.
- 3.) Ultraviolet light treatments are continuous, effective, but only at point of use, must frequently be combined with some more continuous methodology to deal with biofilm, and requires some testing and maintenance. A prefiltration system is necessary. Cost: on average about \$50,000 to install, plus cost of prefiltration system and yearly maintenance costs.

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- 4.) Chlorine or chlorine dioxide is inexpensive, effective, continuous, but has concerns regarding disinfection by-products and damage to pipes when hyperchlorination is used at levels high enough to kill Legionella in biofilm. Typical costs: \$88,000 plus \$48,000 consultant's fee plus annual operating cost of \$7,000.
- 5.) Ozone is effective, the most expensive treatment available, and may be injurious to rubber parts in high enough concentrations.

### **ZETA TECHNOLOGY COMPARISON**

In 1980, the Environmental Protection Agency issued a policy decision that prohibits companies from making claims about Legionellosis prevention or eradication.

Zeta Systems eliminate biofilms from cooling towers, often without the necessity of using any other chemicals. It is our very strong clinical sense, bolstered by the above cited literature that leads us to the following conclusions:

If we eliminate or minimize biofilm better than chemical programs, then protozoa have no "grazing grounds" and no life support. We do this consistently. Extremely low bacterial counts, low protozoal counts, and low Legionella counts meet the criteria for the Cooling Tower Institute Guidelines for the safest of situations in the treatment of water in cooling tower applications. We do this consistently. Our technology is continuous, inexpensive, durable, requires minimal to no maintenance, is not injurious to pipes, rubber parts, or humans. It represents the newest, best, and most complete solution to the problems that promote the growth of Legionella in cooling tower waters that exists on the market today.

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