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Water Bacteria

“**Water bacteria**” is a loose term used to describe bacteria which are frequently found in water. There are several major categories:

The Gram-negative non-fermenters are a group of bacteria that develop in aquatic environments, have very simple growth requirements and are usually not very pathogenic to humans. There is also a group called “non fermentative” Gram-negative bacteria because they do not ferment glucose (they oxidize it). This group includes *Pseudomonas*, *Stenotrophomonas*, *Acinetobacter*, *Flavobacterium* and *Alcaligenes*.

The Vibrionaceae constitute a separate group of Gram-negative rods which are fermenters. The group includes *Vibrios*, *Aeromonas* and *Plesiomonas*. These are normal inhabitants of surface water. Other bacteria that are found in water and that are causes of nosocomial infections are **Legionella** and **Mycobacteria**. *Vibrios*, *Legionellas* and *Mycobacteria* are discussed in their respective sections.

Bacteriology

These bacteria are often able to get carbon and nitrogen from a wide range of organic and inorganic substrates. Organic compounds from the plumbing and storage of water and minute amounts of salts are sufficient to support their growth.

Epidemiology

Most people assume that the hot water in their house is pretty safe. Unfortunately, even here lurk *Mycobacteria*, *Legionella*, *Pseudomonas*, *Acinetobacter* and other potential pathogens. Thus they can easily reach high concentration in water: up to one million colony-forming units (CFU) in tap water for some *Pseudomonas*.

In a moist environment they can survive for a long time: 300 days for *P. aeruginosa* in water; 150 days on a dry filter paper.

These organisms can be found in almost **every moist area of a hospital**. They have been found in distilled water, tap water, sinks, drains, faucet aerators, water fountains, ice machines, hydrotherapy tanks, humidifiers, mouthwash, skin creams, detergents, soap dishes, soaps, antiseptics, mops, contact lens solution, food mixers, kitchen appliances, potted plants and in water baths used to warm solutions. Very strict antiseptic practices are the only methods that can keep these bacteria in check.

Many of these non-fermenters are **naturally resistant to many antibiotics**, including β -lactams and cephalosporins. The mechanisms of resistance vary. Only specially developed β -lactams antibiotics, aminoglycosides and some fluoroquinolones are of some use.

Many are also **partially resistant to antiseptics**. In the 1950s when benzalkonium chloride was used to disinfect needles and catheters, outbreaks of *Pseudomonas* bacteremia did occur. High antiseptic dilution and presence of organic materials in the solution supported growth.

Antiseptic preparations such as chlorhexidine, cetrimide, hexachlorophene and palin soap have been found contaminated with *P. aeruginosa* or *Stenotrophomonas*. Contamination has also been found, but to a lesser extent, in phenolic antiseptics and in povidone-iodine.

Pseudomonas aeruginosa

Pseudomonas aeruginosa is commonly found in all moist environments. The major vehicles used by *P. aeruginosa* to travel the hospitals are food and water. Vegetables are the most commonly contaminated food: surveys of raw vegetables served in hospitals showed that *P. aeruginosa* can be isolated from 10% to 45% of salads. Typical concentrations in these salads are 1,000 CFU /gram.

P.aeruginosa is rarely found as a colonizer of normal humans: 0% to 2% on the skin, 0% to 3% on the nasal mucosa, 0% to 5% in the throat and 0% to 25% in stools. After hospitalization and particularly after antibiotic treatment, the rate of carriage increases and may exceed 50% in some patient populations. The most common colonization site is the rectum (80% of colonized patients); the pharynx and peritoneum are less often involved. The concentration of *P.aeruginosa* in stools may be quite high: up to one to ten million CFU per gram of stools.

Hospital personnel rarely acts as a reservoir of *P.aeruginosa* (rates of colonization \leq 10% and low concentration). Less than 5% of health care workers caring for colonized patients become colonized. Patient-to-patient or staff-to-patient transmission of *P.aeruginosa* via the hands or by other fomites is assumed to occur, but has been difficult to prove.

Transmission of *P.aeruginosa* results from contact with environmental sources or patient-to-patient transmission via the hands of personnel or visitors. Colonized patients serve as an important source of *P.aeruginosa*. When environmental sources are controlled with antiseptics and strict aseptic techniques are practiced, *P.aeruginosa* can be acquired from strains carried in the gut at below detection levels.

Pseudomonas dermatitis and otitis externa outbreaks associated with swimming pool and hot tub use are well described; at least 75 cases during six outbreaks occurred during the 1997 to 1998 timeframe. Dermatitis outbreaks usually occur as a result of low water disinfectant levels, a condition that also increases the risk for transmission of other chlorine-sensitive pathogens (e.g., *Escherichia coli* O157:H7 and *Shigella sonnei*) that may cause severe health consequences.

Pseudomonas cepacia

Pseudomonas cepacia derives its name from the latin word for onion (Coepa) because it is the agent of onion soft rot. It can grow on all sorts of media. It multiplies well in tap water and distilled water by utilizing trace elements and very low concentrations of organic material.

It is much less virulent to humans than *P. aeruginosa*. It is virtually non-pathogenic in a healthy individual. Usually it can only infect severely immunodeficient patients. It is very common as an opportunistic pathogen in cystic fibrosis patients.

P. cepacia transmission from colonized patients to others seems to be much more common than for other water bacteria. Cohorting of colonized patients has led to reduction of transmission to non-colonized patients.

P. cepacia infection may be a severe condition. The mortality of cystic fibrosis patients who become colonized is increased two-fold during the first year after colonization. In the Centers for Disease Control and Prevention (CDC) National Nosocomial Infections Surveillance (NNIS) survey, *P. cepacia* was considered to have contributed to death in 11% of the cases infected by it.

Stenotrophomonas maltophilia

Stenotrophomonas maltophilia is a Gram-negative rod which causes uncommon but difficult to treat infections in humans. Initially classified as *Pseudomonas maltophilia*, *S. maltophilia* was also grouped in the genus *Xanthomonas* before eventually becoming the type species of the genus *Stenotrophomonas* in 1993.

S. maltophilia is ubiquitous in aqueous environments, soil and plants, including water, urine, or respiratory secretions. In immunocompromised patients, *S. maltophilia* can lead to nosocomial infections. *S. maltophilia* frequently colonizes breathing tubes (such as endotracheal or tracheostomy tubes), the respiratory tract and indwelling urinary catheters. Infection is usually facilitated by the presence of prosthetic material (plastic or metal), and the most effective treatment is removal of the prosthetic material (usually a central venous catheter or similar device). The growth of *S. maltophilia* in microbiological cultures of respiratory or urinary specimens is therefore sometimes difficult to interpret and not a proof of infection. If, however, it is grown from sites which would be normally sterile (e.g., blood), then it usually represents true infection.

In immunocompetent individuals, *S. maltophilia* is a relatively unusual cause of pneumonia, urinary tract infection, or blood stream infection; in immunocompromised patients, however, *S. maltophilia* is a growing source of latent pulmonary infections. *S. maltophilia* colonization rates in individuals with cystic fibrosis have been increasing.

S. maltophilia is naturally resistant to many broad-spectrum antibiotics (including all carbapenems), and is thus often difficult to eradicate. Many strains of *S. maltophilia* are sensitive to co-trimoxazole and ticarcillin, though resistance has been increasing. It is not usually sensitive to piperacillin; sensitivity to ceftazidime is variable.

Elizabethkingia meningoseptica

Microbiology

Elizabethkingia meningoseptica is a nonfermentative Gram-negative bacillus, obligate aerobic, non-fastidious, non-spore forming, nonfermentative; nonmotile; slender; slightly curved rod; and catalase positive, oxidase positive, and indole-positive.

It is widely distributed in nature (fresh water, salt water, or soil). It may be normally present in fish and frogs but is not normally present in human microflora.

Epidemiology

E. Meningoseptica is not typically considered a human pathogen but it is capable of causing a variety of nosocomial infections in cerebrospinal fluid, blood, skin, respiratory system and other body sites. While *E. Meningoseptica* is rarely isolated from clinical specimens, there have been a number of outbreaks associated with this bacterium causing meningitis in newborns - linked to environmental sources, mainly water-containing equipment. High mortality rates and neurological sequelae in surviving neonates often result from these outbreaks. Rarely, it is the cause of nosocomial pneumonia, endocarditis, post-operative bacteremia and meningitis in immunocompromised individuals.

E. Meningoseptica is ubiquitously found in hospital environments and as such, it has been associated with various nosocomial infections. Immunocompromised individuals are particularly at increased risk for developing severe infections due to *E. meningoseptica*, including bacteremia.

In 1959, it was found to be associated with pediatric meningitis and sepsis, (named *Flavobacterium meningosepticum*). In 1994, it was reclassified in the genus *Chryseobacterium* and re-named *Chryseobacterium meningosepticum*.

Antimicrobial susceptibility

E. Meningospetica is usually multiresistant to antibiotics used to treat Gram-negative bacterial infections, including extended-spectrum beta-lactam agents (due to production by most strains of two betalactamases: one ESBL and one Class B Carbapenem-Hydrolyzing metallolactamase), aminoglycosides, tetracycline. Though vancomycin has been used in the past, its high MIC (16 µg/ml) has led to a search for alternatives, especially for meningitis. Presently ciprofloxacin, minocycline, trimethoprim-sulfamethoxazole, rifampin and novobiocin are considered good alternatives. Most of these are classic drugs for Gram-positive bacteria and not routinely tested on gram negative bacteria.

Acinetobacter

Acinetobacter was formerly described as *Mima*, *Herellea* or included with the *Moraxella* or *Achromobacter* groups. It is widely distributed in nature and among animals. It can be found in virtually 100% of soils or waters. It is also part of the normal flora of animals or of humans. It has been cultured from frozen foods and pasteurized milk.

The most common sites of colonization in healthy individuals are the skin (50%), the pharynx (5%), but also the conjunctiva, urethra and vagina. It is the most common Gram-negative bacteria carried by hospital staff. After hospitalization, colonization rates increase: up to 50% of tracheostomy sites are colonized in some hospitals.

Because *Acinetobacter* is part of the normal flora, its isolation does not always mean that it has a pathogenic role. In a study of patients with *Acinetobacter* bacteremia, it did not appear that the infection caused any excess mortality beyond what was expected from the underlying conditions.

Sphingomonas

Sphingomonas, a new genus whose name was first proposed in 1990, contains one species that is an occasional human pathogen, *Sphingomonas paucimobilis*. This organism, formerly known as *Pseudomonas paucimobilis* and CDC group IIk-1, is widely distributed in soil and water, including water sources in the hospital environment. It has been implicated in nosocomial outbreaks associated with contaminated water and contaminated ventilator temperature probes.

S. paucimobilis infections typically occur in immunocompromised persons and can be community- as well as nosomionally-acquired. This is an organism of low virulence, and recovery from infection is the rule, even in debilitated hosts. There are several reports of *S. paucimobilis* intravascular catheter-associated blood stream infection, and catheter removal was necessary in some cases for cure. Blood stream infection has also been reported in hemodialysis patients and after infusion of contaminated autologous bone marrow. Although ventilator-associated pneumonia has been described, airway colonization was much more common than infection in intensive care unit outbreaks. Peritoneal catheter-associated peritonitis, meningitis, ventriculo-peritoneal shunt infection, brain abscess, soft tissue infection, wound infection, adenitis, urinary tract infection, and a variety of visceral abscesses have been reported.

S. paucimobilis is strictly aerobic, oxidase-positive, and catalase-positive. Colonies grow on blood agar, but not MacConkey's agar, produce a yellow pigment, and can be misidentified as *Flavobacterium* spp. Despite the presence of a single polar flagellum, a low percentage of cells are actively motile, and motility can be difficult to demonstrate in the laboratory (thus the name *paucimobilis*).