Water Wonderful Life

Potable water hygiene for medical practices

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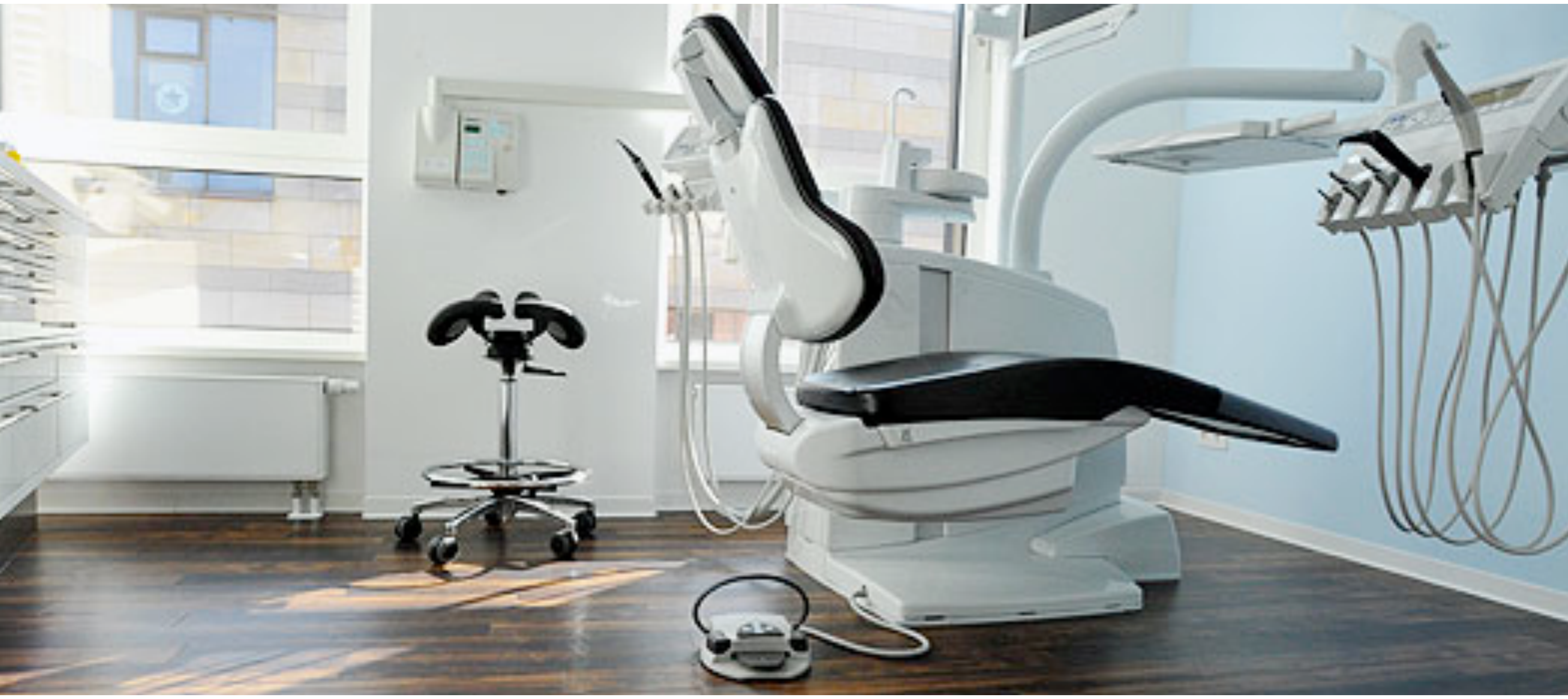


Potable water hygiene for dental practices

Pathogens from potable water often lead to elevated bacterial counts in treatment equipment and thus to increased risk for the patient and the dentist

Potable water hygiene plays an important role in dental treatment. The treatment equipment is central to this role, on the one hand via the water mist formed during treatment, while on the other via direct wound contact; thus both the patient as well as the treating personnel coming into contact with mains water need to be aware of the pathogens contained therein.

Among the most common infections that can be caused here is certainly infection through Legionella which can cause serious pneumonia. In addition, pathogens such as Pseudomona Aerigunosa are often detectable in the treatment equipment.

Studies have shown elevated counts of legionella - antibodies with dentist personnel as well as modifications of bacteria growth on dentists nasal mucous membranes. [1]

But how do pathogens get into the treatment equipment?

The problem

Water that is used by dental treatment equipment must at least meet the requirements of local Drinking Water Regulation.

Beyond this, national hygienic organizations, like the German Robert-Koch Institute as well as industry associations such as the American Dental Association recommend that in the treatment of immunosuppressed patients, the water should be free of pathogens[2,3].

At the interface with the mains water supply, the so-called „Point-of-Entry", potable water may contain certain amounts of pathogens, such as up to 100 Legionella per 100 ml, measured by plate-count in colony-forming units.

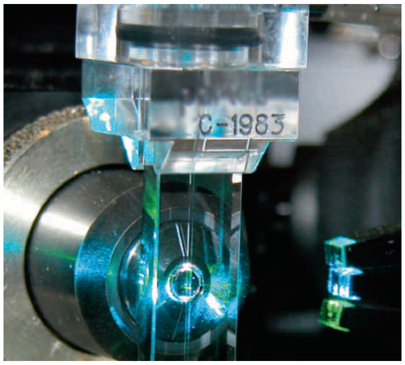
Thus pathogens such as Legionella or Pseudomonas, but also a variety of other microorganisms from the cold water, is supplied to the system in the building and therefore into the dental practice[4,5].

If sufficient nutrients, high bacterial count and adequate temperatures are present, pathogens can then multiply there extremely quickly.

Test methods

According to standards of Drinking Water Regulation (also the one in Germany), pathogens in potable water may only be determined by means of plate-count methods. However, nowadays, it is known that only 0.1 - 1% of all active cells in water are prone to the formation of colonies that can then be counted on a culture medium[6].

Therefore, advanced methods are often applied in medical technology for the detection of pathogens, such as flow-cytometry[7]. In this method, the water from the sample is obtained via a thin glass cannula. The water is then irradiated with a laser beam. The organisms present in the water then refract the light and this is captured by various sensors. Thus, an accurate indication of the number and type of microorganisms is obtained.



The picture shows the laser of a flow-cytometry system, which penetrates a thin water channel inside the glass cannula and gets refracted at the DNA of the bacteria therein.

Microbial growth in the supply network

Scientists now know that potable water at the interface point in buildings contains between 40,000 and more than 200,000 bacteria per one milliliter (!)[8]. These bacteria form a strong biofilm growth in the pipes of the building and thus, of course, also the dental practice therein[9].

Biofilms form an excellent shelter and protection for pathogens. Pathogens are largely protected within a biofilm against disinfection methods; chemicals or heat are often unable to penetrate the biofilm that always thrives in dead spaces that are difficult to reach[10].

Nourished by metabolites from the surrounding cells, but also often from the recyclable content of potable water (nitrate, phosphate, natural organic compounds), the pathogens also multiply rapidly at temperatures between 20 °C (68 °F) and 50 °C (122 °F), doubling their count every 4 to 7 hours[11].

Example of a dental practice in Munich, Germany

How high the biomass that is already washed into the building from the mains supply can be, is demonstrated by research performed at the Point-of-Entry to a dental practice in Oberschleißheim in Munich. While the officially prescribed examinations, based on plate count methods, showed total colony-forming units of two (at 22 °C, 72 °F) and 60 (at 36 °C, 97 °F), scientists from the Swiss Federal Institute of Technology in Zurich determined a total count of 69,755 active microorganisms per milliliter from the same water samples using flow cytometry.

	Plate Count method (HTC) count per 100 ml			**Flow Cytometry**
	22 °C 72 °F	36 °C 97 °F	Legionella spp	Count per 100 ml
Total cell count	200	6.000	n/a	6.975.500
Legionella			0	8.600

TCC and Legionella Heterotrophic plate count at 22°C und 36°C. Right column: numbers of cells present in water, measured using flow cytometry method. Measured at point of entry of a dental practice in Munich (Germany) at probing point #1 (see above).

Existing installation

Downstream the point-of-entry of the building's water-line into in the dental practice, a fine filter with a 100 µm cut-off is installed. Considering the size of a Legionella and bacteria of about 1 µm, one can imagine that such standard fine filter is ineffective with respect to the retention of biomass from the mains supply - followed by a softener that protects the equipment of the practice from calcification.

From there, the supply network branches to seven treatment and prophylaxis units.

All treatment units are equipped with a dosing system for line conservation („Alpro Weekend System"), dosing a chemical called „Bilpron" into the lines and hoses of the chair in order to disinfect it.

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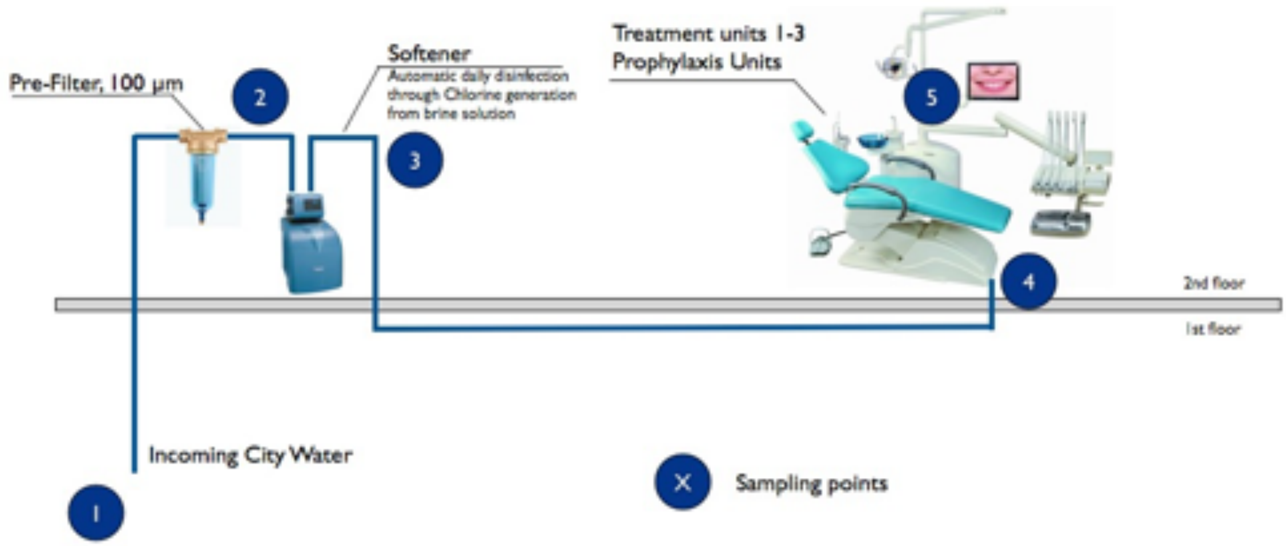

Basic scheme of the installation of a dental practice in Munich (Germany). The dental practice had violated the legionella guidelines in the treatment chairs of 100 / 100 ml significantly. All conventional methods of disinfection had failed.

The dosing system also provides for regular flushing of the chairs' water lines to prevent stagnation.

Even a flushing protocol, as posted by Germany's national hygienic organization, the Robert-Koch Institute, had been implemented and regular flushes have been performed.

Test results without disinfection measures

Initially, samples were taken at the point of entry into the practice (1), in front of (2) and after the softener (3), at the connection to the treatment chair (4) as well as at the mouth rinsing point and tools (5).

Probing Point	sampled temperature	Plate Count HTC @ 22 °C (72 °F)	Plate Count HTC @ 36 °C (97 °F)	Legionella
(1) Point of Entry	16 °C 61 °F	0	0	n/a
(2) pre softener	18 °C 64 °F	2	60	**86**
(3) post softener	22 °C 72 °F	**900**	**1200**	**44.436 (FC)**
(4) Floor-Connector of treatment chair	21 °C 70 °F	606	0	**50**
(5) Mouth rinse	n/a	1	0	**10**

All **values per Milliliter** using conventional plate count method (HTC), except legionella at sampling point #3, those were analyzed using Flow Cytometry (FC). Bold values show where regulatory thresholds are exceeded.

Most critical all the values for Legionella exceeded the threshold specified in the Drinking Water Guideline (100 per 100 ml) in some cases even significantly, while the measured values for colony forming units at 22 °C were greatly increased.

After the first sampling by means of the plate count method, random-sampling measurements were performed for Legionella using flow-cytometry. At the sampling point right downstream the softener 4.4 million Legionella per 100 ml were observed.

Softeners are a source of risk

In standard softeners, the water flows through a container filled with small plastic pellets with very large surface areas.

Initially, the surfaces of the pellets are loaded with common salt. During softener operation, the hardness in the water clings to the surfaces of the pellets, whereby salt is „pushed" from the pellets into the water. From time to time, the softener is flushed with a saline solution in order to replace the hardness on the surface of the pellets with salt.

The large surface area of the pellets is very well suited for growth of bacteria. Accordingly very high bacteria counts were found in the softened-water, including pathogens such as Legionella.

Some devices offer the possibility of regular or continuous "sterilization" where the pellets are sterilized by the introduction of small amounts of chlorine gas which is generated from the available saline solution through electrolysis. However, as a rule, not enough chlorine can be dosed to sterilize the large surface area of the pellets.

During regeneration of the softener through a salt brine, a lot of bacteria are killed by the high salt content. Legionella do survive such high salt concentrations and feed of the large amount of now available dead biomass, making their population grow significantly.

The installation of Seccua filtration after the softener is needed as a barrier.

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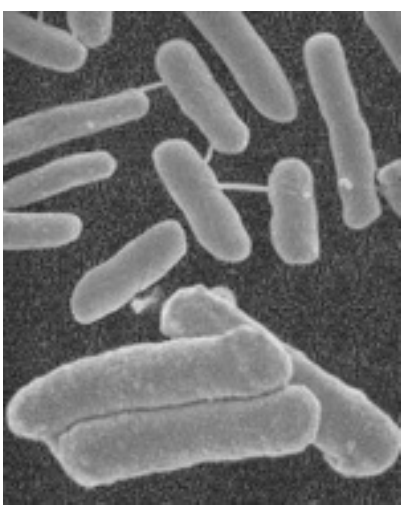
Basic scheme of the installation of a dental practice in Munich (Germany). The dental practice had violated the legionella guidelines in the treatment chairs of 100 / 100 ml significantly. All conventional methods of disinfection had failed.

Use of Seccua Filtration as a firewall against micro-organisms

In order to reduce the microbial load of the water supply network, a Seccua Filtration unit was installed after the softener at the cold water inlet.

These ultra-fine filtration units with pores of 20 millionths of a millimeter (20 nanometers) completely retain all pathogens and microorganisms.



Legionella and E-Coli on Seccua Filter's membrane surface. The filter's ultra-fine pores can be seen in the background.

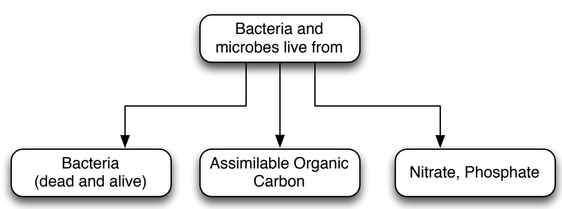
Alive and dead bacteria are a major nutrient for bacteria and parasites up higher in the food-chain of micro-organisms, like Legionella and Amoeba.

Removing all micro-organisms from the water before it enters into the practice's water system therefor takes away that major source of food and leads to a steep reduction of existing biofilm in the lines.

In areas, where high loads of assimilable carbon is in the water, like e.g. in water systems which are fed from surface water sources, activated carbon filters should be installed as an additional step in reducing nutrients for the biosphere in the waterlines even further.

Regular automatic flushes of the Seccua filters wash the rejected particles and biomass out to drain.

Typically within a few weeks after installation of a Seccua filter into existing water-networks at Point-of-Entry of the water-line into a practice or building, the number of micro-organisms in the water lines decreases significantly and keeps lowering until it levels, often at stages where e.g. Legionella are then reduced to non-detectable.



In new practices or buildings Seccua filtration offers an unique opportunity to protect the entire „fresh" pipeline system against pathogens from the outset.

Results after installation of Seccua filtration

Only a UrSpring Medical Filtration unit was retrofitted into the existing installation at Point-of-Entry into the cold-water line, downstream the softener.

Only four weeks after installation of the filter system, the concentration of Legionella sampled at the connection point of the treatment chairs to the water-lines, had fallen to below detection levels of plate count methods.

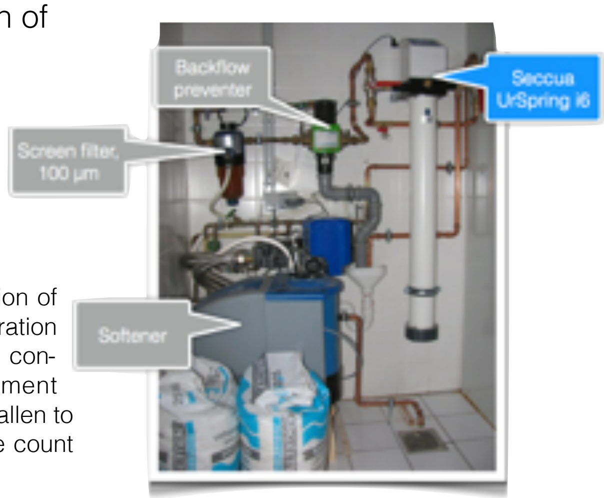
Background analysis, applying Flow-Cytometry, performed to count all bacteria really present at the sampling point (4), showed that total cell counts had dropped from initially around 400,000 per Milliliter to around 50,000, a reduction of nearly 90%, although to get to the sampling point the water travels through several yards of pipe that had not been cleaned out in any way since the installation of the Seccua filter.

Cost of the installation

The installation of Seccua Ultrafiltration was performed on a Saturday without the dentist's schedule being disrupted.

The cost of the Seccua UrSpring Medical filtration unit amounted to $4,390, while installation cost amounted to approximately $2,000.

The annual maintenance costs for the equipment will be around $600 for replacing the filter cartridge and inspection.



Installation of a Seccua UrSpring Medical unit for complete removal of pathogens and bacteria at the Point-of-Entry to a Dentist Practice. The unit is installed downstream the softener.

Further measures

In cases of severe contamination of existing piping systems it is recommended to apply a combination of measures:

- A Seccua Filter, installed at Point-of-Entry will greatly decrease nutrient supply for existing biofilm.
- As an addition, a GAC-filter, such as the UrSpring BioFilter will further reduce dissolved organics in water and therewith drive down the content of nutrient even further.
- Dead-strains have to be detached from the piping system.
- After installation of the treatment systems, an air-water scour should be performed through every point-of-use or connecting point to mechanically reduce existing bio-growth.
- A flush-plan for regular flushing through every Point-of-Use should be defined in order to prevent standing water within the piping network.

Dosing of chemicals in the supply system

Chemicals should only be used for permanent sterilization when it can be ensured that the chemicals are able to penetrate in sufficient concentration at each point of the pipeline system including the dead spaces.

It has to be taken into consideration, that disinfection chemicals typically are aggressive on all known piping materials

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