Dental unit waterline – cleaning systems
There are commercially available manual and automatic systems for minimizing the microflora in dental units. The use of one type of disinfectant has not been shown to have any lasting effect. A well-established biofilm causes constant regrowth of microflora. To achieve a lasting effect, disinfectants must be combined with a suitable agent, effective in removing the biofilm, combined with regular maintenance disinfection.

There are several good brand names for cleaning/disinfectant systems available on the market – devices with published scientific documentation should be encouraged.

Biofilm - a well documented fact
The presence of biofilms and microorganisms in the dental unit's water system has received increasing attention. High counts of bacteria in dental unit waterlines are well documented and have been described in several scientific articles during the last decade. However, there are only four published scientific articles where microbial colonization of the dental unite waterline could be directly related to contamination of patients or personnel.

Hazard to patients and personnel alike
In dentistry most treatment procedures require water: flushing, cooling or simply rinsing the mouth. Three-way syringes, rotating instruments and ultrasonic scalers generate very fine aerosols which the patient may inhale during treatment. The aerosol and the microorganisms it may contain can thus enter the patient's respiratory tract. Special attention should be paid to patients with temporary or chronic immunodeficiency. There are case reports in which serious infections in patients can be traced to dental treatment.

Biofilm in dental unit waterlines is a hazard to the dental staff. There are several studies showing increased antibody titres to *legionella pneumophila* among dental health care personnel. Changes to the bacterial flora in the nostrils of dentists, with increased *pseudomonas,* have been shown to be associated with growth of *pseudomonas* in the water in the dental unit.

Negative effect on equipment and composite restorations
The amounth of biofilm will also affect the function of the dental unit as well as the maintenance and reliability of dental handpieces. Recently it has been showed that increasing concentrations of bacteria in water used to wash etched enamel result in a corresponding decrease in both shear bond strength and critical surface tension of enamel.

Biofilm where there is humidity and nutrition
There is always a biofilm with smaller or larger quantities of microorganisms in all watersystems. Microorganisms multiply where there is access to biological material that could be used by the microorganisms for metabolism and energy production.

In the oral cavity, bacterial plaque is constantly being formed on the surfaces of the teeth – the bacterial plaque is the "biofilm of the oral cavity". The biofilm in dental unit waterlines develop in analogy with the plaque formation in the oral cavity but by different microorganisms.

Heterotrophic bacteria – a good indicator
The microorganisms which appear early in the biofilm are usually non-pathogenic. But because the bacteria attach to the plastic of the hoses in the unit's water system and in joins and valves, a complex biofilm is successively formed. The biofilm serves as an excellent breeding ground for pathogenic microorganisms. A very varied microflora has been disclosed, from *heterotrophic Gram-negative bacteria, legionella, pseudomonas* to *fungi* and *protozoa.*

Heterotrophic bacteria have the ability to use carbonic compounds in the surrounding environment for their metabolism. By measuring the amounth of heterotrophic bacterias in waterline systems it is possible to get a god estimate of the contamination level and the microbial quality of the water.

Regulations and recommendations for drinking water

Drinking water starts to tast noticeably ill when the counts of *heterotrophic Gram-negative bacteria* > 10.000 cfu/ml, colony forming units (number of bacteria) per millilitre. The American Dental Association (ADA) in collaboration with Centre for Disease Control and Prevention (CDC) have defined the highest admissible concentration of *heterotrophic Gram-negative bacteria* to < 200 cfu/ml and there should be no pathogenic microorganisms.
For qualitycertification in accordance with Danish Standard the Danish authorities requires that the microbial quality of the water from the dental unit should be equivalent with the incoming council-reticulated drinking water.

In the EU-norm drinking water there are not, at present, any limits for l*egionella* nor for *pseudomonas*. There are, however, limits for *heterotrophic Gram-negative bacteria.* In microbial samples drinking water should have less than 100 cfu/ml after 2-days incubation and less than 5 000 cfu/ml after 7-days incubation.For disinfected water the concentration *heterotrophic Gram-negative bacteria* must not exceed 10 cfu/ml following 2 days incubation.
Within dentistry there is a large number of studies demonstrating levels of heterotrophic bacterias several thousand times higher than accepted concentrations for drinking water.

Legionella in dental unit waterlines
Several investigations have disclosed high concentrations of *legionella* in a large number of dental units. In a Danish study, *Legionella* could be cultured from 11% of tested dental units. Studies from other countries have demonstrated even higher prevalence of *Legionella* in dental unit waterlines.

Legionella occur naturally in water, often in such small amounts that they cannot be detected by analysis, but in stagnant water they flourish, at temperatures between +20^{o}C and +60^{o}C. The most effective means of killing these bacteria is by increasing the temperature of the water.

Legionnaire's disease is usually caused by the bacterium *Legionella pneumophila.* Legionella bacteria flourish in stagnant water. Their thermal sensitivity is relatively low and they can proliferate at temperatures between +18°C and +45°C . They can colonize common water reticulation pipes (especially ”dead ends”), fire sprinkler systems, water containers for ice-making machines, humidifiers, water towers, air conditioning plants, showers and spas. Growth is facilitated by the biofilm which is almost always present on the walls of water tanks, water reticulation pipes and shower hoses. Reservoirs (growth loci) for *Legionella pneumophila* are primarily hot water systems

Legionella pneumophila grows locally, in niches in the water system and most frequently at the actual terminal of the water suppply, i.e. the taps.

Low water flow and elevated temperature stimulates bacterial growth
Flushing out the water system has a temporary positive effect in reducing the microbial burden in the system. To be effective flushing should be done daily for several minutes, at the beginning of the working day, at least 8 minutes of flushing is necessary to reach levels below 500 cfu/ml.
However, development and implementation of automatic systems for minimizing the microflora in dental units must be urged, proper methods of achieving potable water is required.

The problem with biofilm in the dental unit waterline system has little to do with water supply itself – the problem lies within the dental unit.
A major contributing factor is that the dental unit is not in use for 24 hours a day – the water therefore only circulates in the system during active working hours and the waterflow is even then very low. The average water consumtion in a dental unit is only 1 drop per second (2 drops = 1 milliliter). The total amount of water in the dental unit waterline system is as low as 100 ml. The low usage of water will contribute to increased water temperature which will stimulate the growth of microorganisms already existing (in low numbers) in the provided fresh drinking water system.