



MAKE YOUR WATER SAFE

Preventing dental unit waterline contamination.

By John A. Molinari, PhD

Dental waterlines can become contaminated by organisms that colonize the system, rapidly leading to the formation of biofilms inside the lumens of the waterlines. Although the water coming into dental waterlines is sanitized and meets public health safety standards for potable quality (<500 cfu

(colony forming units)/mL of bacteria and <1 coliform), water coming out of dental waterlines may contain up to 1,000,000 cfu/mL of bacteria. This contamination occurs because certain dental waterline factors (eg, system design, flow rates, materials) promote bacterial growth and the development of biofilm.¹⁻³

In 1995, the American Dental Association issued a statement on the quality of water used in dental treatment—encouraging industry and researchers to improve the design of dental equipment and to provide equipment with the ability to deliver treatment water with 200 cfu/mL or less of unfiltered output from water lines.⁴⁻⁵ Similar standards are in effect for dialysate, one of the fluids used in dialysis. Standards also exist for safe drinking water quality as established by the Environmental Protection Agency (EPA), the American Public Health



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Association (APHA), and the American Water Works Association (AWWA), which set limits of no more than 500 cfu of heterotrophic bacteria per mL of drinking water. The number of bacteria in water used as a coolant/irrigant for nonsurgical dental procedures should be less than the 500 cfu/mL regulatory standard for safe drinking water established by the EPA, APHA, and AWWA.^{7,8}

Many products are available that address the composition, mechanisms of microbial accumulation, potential health risks, and the reduction of microbial accumulation in the dental operator. As a result, dental health care workers (DHCW) are faced with many product choices and, unfortunately, they sometimes come upon confusing, conflicting information that can make subsequent purchasing decisions difficult.

WHAT TYPES OF MICROORGANISMS HAVE BEEN ISOLATED FROM COLONIZED DENTAL WATERLINES?

Research has identified multiple classes of organisms in dental waterline samples—ranging from nonpathogenic to pathogenic spectrums of microbes.^{1,3,6} Types of microbes commonly associated with dental waterlines are *Bacterionema* spp.; *Corynebacterium* spp.; gram negative bacilli and cocci; *Klebsiella* spp.; *Neisseria* (*N. catarrhalis*); *Pseudomonas* spp., including *P. aeruginosa*, *P. pyogenes*, and *Burkholderia capacia*; *Staphylococcus epidermidis*; *Streptococcus mutans*; *Streptococcus salivarius*; *Streptococcus mitis*; *Actinomyces* spp.; *Enterococcus* spp.; α hemolytic streptococci; *Staphylococcus aureus*; *B. subtilis*; *E. coli*; *Flavobacterium*; nonhemolytic streptococci; *Legionella pneumophila*; *Mycobacterium* spp.; *Aspergillus niger*; *Cladosporium*; *Achromobacter*; and *Alcaligenes faecalis*. Even small roundworms have been found in contaminated dental waterlines.

Most of the isolated microbes are from the public water supply and are classified as

opportunistic pathogens, meaning they do not usually pose a high risk of disease for healthy persons. This fact has direct implications for dentistry because increasing numbers of patients routinely seek dental treatment who have weakened immune systems and who may be periodically exposed to microbial opportunists via colonized water.⁹ Infections in this type of patient are a problem following medical exposure to waterborne pathogens, such as *Pseudomonas*, *Klebsiella*, *Legionella*, and nontuberculous *Mycobacterium* species. Since these bacteria have been isolated in dental water supplies, we need to learn from the experiences of our medical colleagues by taking steps to minimize colonization and, therefore, the potential for infection and illness in immune compromised individuals.

Despite the presence of potentially pathogenic bacteria in numbers greatly exceeding levels established for drinking and recreational waters, few cases of illness among DHCWs or patients have been confirmed. However, because most dental offices are located in outpatient settings, epidemiological links between an infection and recent exposure to contaminated dental water are difficult to establish. The relatively small quantity of water entering a patient's mouth during routine dental treatment is a possible reason for the lack of documented infection. Exposure to aerosols and entrance of contaminated water into open wounds are also possible routes of microbial transmission. Moreover, the widespread application of effective, accepted infection control principles and the high level of asepsis standards routinely exhibited in most dental facilities reduces the risk of exposing either patients or DHCW to water of poor microbiological quality.

WHAT ARE BIOFILMS?

Biofilm is a bacterial film that tightly adheres and lies flat against the walls of the dental water-

line. It is characterized by cells that:

1. Are irreversibly attached to a substratum or interface with each other;
2. Are embedded in a matrix of extracellular polymeric substances that they have produced; and
3. Grow as a distinct community of bacteria and other microorganisms acting as a self-perpetuating and self-protecting unit.

Biofilms are virtually ubiquitous—existing in all environments where there is water and a suitable solid substrate for attachment. They can harbor numerous waterborne bacteria, fungi, protozoa, even roundworms. While at first glance biofilms may appear as simple amorphous masses on water-laden surfaces, they can have a surprisingly complex structure.⁹ It is possible for clumps of biofilm to become dislodged and come out as solid material when water flows through dental waterlines, which is of particular importance to both possible infectious exposure and the public's perception of microbial exposure.

WHAT ARE THE CURRENT RECOMMENDATIONS FOR ADDRESSING DENTAL WATER ASEPSIS?

The most recent Centers for Disease Control and Prevention (CDC) infection control guidelines recommend that potable water be used for routine dental care and that sterile water be used for surgical procedures that involve exposure of bone, the vascular system, or tissue that is normally sterile.² Table 1 (page 44) lists the CDC Recommendations for Dental Unit Waterlines, Biofilm, and Water Quality.

Ongoing efforts by manufacturers continue to provide DHCW with multiple choices for controlling the quality of source water used in patient care, including:

1. An alternate water supply that bypasses community water systems and dental waterlines by providing sterile or distilled water directly into water line attachments (ie, separate reservoir) combined with chemical treatment.
2. Filtration involving in-line filters to remove bacteria immediately before dental unit water enters instrument attachment.
3. Chemical disinfection involving periodic flushing of lines with a disinfectant fol-

Table 1. CDC Recommendations for Dental Unit Waterlines, Biofilm, and Water Quality.**General Recommendations**

1. Use water that meets EPA regulatory standards for drinking water (ie, <500 cfu/mL of heterotrophic water bacteria) for routine dental treatment output water.
2. Consult with the dental unit manufacturer for appropriate methods and equipment to maintain the recommended quality of dental water.
3. Follow recommendations for monitoring water quality provided by the manufacturer of the unit or waterline treatment product.
4. Discharge water and air for a minimum of 20 to 30 seconds after each patient from any device connected to the dental water system that enters the patient's mouth (eg, handpieces, ultrasonic scalers, and air/water syringes).
5. Consult with the dental unit manufacturer on the need for periodic maintenance of anti-retraction mechanisms.

Special Considerations for Oral Surgical Procedures

1. Use sterile saline or sterile water as a coolant/irrigant when performing oral surgical procedures. Use devices specifically designed for delivering sterile irrigating fluids (eg, bulb syringe, single-use disposable products, and sterilizable tubing).

followed by appropriate rinsing of lines with water or a continuous release chemical disinfection system.

4. Thermal inactivation of facility water at a centralized source.

5. Reverse osmosis or ozonation using units designed for either single chair or entire practice waterlines.

6. Ultraviolet irradiation of water before entrance into individual unit waterlines.

Even though many choices exist for cleaning and maintaining waterlines, some require a substantial commitment by personnel. One of the more popular options is the use of chemical agents either continuously or added periodically to clean waterlines. While no available chemical meets all standards, Table 2 lists the criteria that should be used to evaluate the efficacy and safety of dental waterline agents.^{9,10}

While it is fortunate that multiple options are available, the key for accomplishing dental waterline asepsis remains the same as for other infection control issues: use basic infection control principles in the selection of a strategy while ensuring personnel compliance with specified protocols. Contaminated waterlines—like contaminated hands, instruments, and environmental surfaces—should first be cleaned to remove accumulated microbial and extracellular material. Compliance with the manufacturer's

step-by-step procedure for accomplishing this removal is essential. Minimizing subsequent dental waterline colonization may require another series of protocols, some of which may be more time consuming than anticipated. Thus, the whole dental team needs to be aware of product costs, necessity for compliance, and the time required to reach recommended dental waterline microbial concentrations.

Research developments in recent years have led to not only greater individual options for dental practi-

tioners, but also to the availability of combination system products, which contain separate waterline cleaning agents and maintenance chemicals. This approach minimizes the possible confusion that can arise from evaluating, purchasing, and using multiple types of products from different manufacturers.¹¹ Remember to ask

Table 2. Criteria to evaluate dental waterline cleaning agents.

- Nontoxic to equipment or patients
- Nonpyrogenic
- Nonallergenic
- Noncorrosive to metals
- No damaging effects on rubber or synthetic materials
- Does not interfere with performance of any dental restorative or therapeutic agents
- Rapid "cidal" (ie, lethal) antimicrobial action
- Exhibit broad-spectrum antimicrobial activity against bacteria, fungi, and protozoa
- Ability to disrupt/disperse accumulated biofilms
- Exhibit substantivity to minimize or prevent microbial accumulation on treated surfaces
- Eco-friendly or "green"

the appropriate questions when discussing available product choices with manufacturers' representatives and then be certain to evaluate what approach will work best in your specific facility. **D**

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