

Microbial contamination of dental unit waterlines: the scientific argument*

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Summary

The quality of dental unit water is of considerable importance since patients and dental staff are regularly exposed to water and aerosols generated from the dental unit. The unique feature of dental chair water lines is the capacity for rapid development of a biofilm on the dental water supply lines combined with the generation of potentially contaminated aerosols. The biofilm, which is derived from bacteria in the incoming water and is intrinsically resistant to most biocides, then becomes the primary reservoir for continued contamination of the system. Dental water may become heavily contaminated with opportunistic respiratory pathogens such as *Legionella* and *Mycobacterium spp.* The significance of such exposure to patients and the dental team is discussed. There is at the present time, no evidence of a widespread public health problem from exposure to dental unit water. Nevertheless, the goal of infection control is to minimise the risk from exposure to potential pathogens and to create a safe working environment in which to treat patients. This paper evaluates the range of currently available infection control methods and prevention strategies which are designed to reduce the impact of the biofilm on dental water contamination, and are suitable for use in general practice. Bacterial load in dental unit water can be kept at or below recommended guidelines for drinking water (less than 200 colony forming units/ml) using a combination of readily available measures and strict adherence to maintenance protocols. Sterile water should be employed for all surgical treatments.

The aim of providing dental unit water (DUW) that can be used safely with all patients has become a priority issue world-wide uniting dental governing bodies, research scientists and dental equipment manufacturers. In the USA and Europe major outbreaks of waterborne infections caused by cryptosporidium¹ affecting in some instances thousands of people who consumed the contaminated drinking water has fuelled widespread public concern regarding the integrity of the municipal water supply. This public lack of confidence in water quality is illustrated by an exponential increase in sales of bottled water in many countries, even though the microbiological content of many of these products vastly

exceeds that found in tap water^{2,3}. Evidence has been steadily accumulating on dental unit water microbiology for over 30 years. Dental aerosols, irrigant and coolant water entering the patient's mouth during dental procedures often contain large numbers of organisms in the range 10⁴ to 10⁸ colony forming units (cfu)/ml⁴. Such water, if judged by drinking water standards set in Japan of <100 cfu/ml, in Europe <200 cfu/ml and in America of <500 cfu/ml would not be considered fit for human consumption. Internationally, the important public health issue that forms the backbone of all water standards is the use of coliform counts as an indicator of sewage or faecal contamination of drinking water. Safety standards do not exist for the quantification of opportunistic Gram negative bacterial species or respiratory pathogens that are found in low numbers in

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the mains water supply but which are amplified and constitute numerically the most important organisms found in DUW⁵.

Dental water may be ingested, inhaled in the form of aerosols or directly contaminate surgical wounds. Dentists have a duty of care to their staff and patients. It is deemed ethically unacceptable to knowingly expose patients to contaminated water. Guidelines on preventive measures for reducing DUW contamination have been issued by government agencies such as the CDC Atlanta, USA, the mainstay of which is flushing of dental units⁶. The consensus opinion is that water used for restorative procedures should be of the same quality 'as for drinking water'. A recommendation has been issued by the American Dental Association⁷ that by the year 2000, water for non-surgical procedures should contain no more than 200 cfu/ml of aerobic bacteria in DUW. Separate sterile water supplies are advised for surgical procedures⁸. Coolant water or saline used for surgical procedures should be sterile, and should not be contaminated during delivery. Devices used to deliver the sterile water must be sterilised before use for invasive procedures. This paper will examine why contamination of the DUW occurs, will assess the relative risk of contaminated water and aerosols to dental surgery staff and patients and will critically evaluate currently available solutions to the problem.

Biofilms in DUW

Bacteria in aquatic environments interact with surfaces to form a biofilm, a strategy developed to aid survival and optimise available nutrients. The physics of laminar flow of DUW passing through the waterlines results in maximum flow at the centre of the lumen and minimal flow at the periphery, encouraging deposition of organisms onto the surface of the tubing⁹. Intermittent use patterns of dental lines leads to stagnation of the entire water column within the waterlines for extended periods during the day, thus promoting further undisturbed bacterial proliferation. Dental units are equipped with microbore (approximately 1mm diameter) flexible tubing which has a high ratio of lumen surface area to water volume. Narrow bore tubes are inaccessible to mechanical debridement or 'pigging' processes commonly employed to maintain the functional integrity of wide bore industrial style water supply lines. Bacteria adhere more readily to hydrophobic polymeric plastic tubing of the type utilised in dental equipment (for example, polyvinyl chloride, polyurethane) than to those composed of glass or steel¹⁰. Susceptibility of medical equipment such as catheters to biofilms has been reduced by coating with heavy metals or incorporating biocides into the fabric of the tubing that inhibit bacterial growth¹¹. Similar materials may be of future value in dental units.

Organisms in DUW biofilm are predominantly derived from the incoming mains water. Once a new

DUW system is connected to mains water supply, even when it is not used for patient treatment, a biofilm will form (and be releasing high numbers of planktonic organisms) within 8 hours¹². The biofilm will develop to reach a climax community of micro colonies embedded in a protective extracellular amorphous matrix by 6 days¹². Bacteria shed from the biofilm during use maintain the bio-burden of planktonic (suspended) organisms detected in DUW. Characteristically biofilm bacteria exhibit greater resistant to surfactants, biocides and antibiotics than organisms floating freely in fluids¹³.

Risks to patients

There is no evidence of a widespread public health problem from exposure to DUW. Nevertheless, the goal of infection control is to minimise the risk from exposure to potential pathogens and to create a safe working environment in which to treat patients. The ever increasing number of patients who are either immunocompromised or immunosuppressed due to drug therapy, alcohol abuse or systemic disease has produced a cohort of patients susceptible to environmental waterborne opportunistic pathogens such as those prevailing in DUW (*Table 1*). The organisms recovered from dental unit water vary with geographic location. They include fungi, free living amoebae, protozoa and nematodes as well as the consistently reported recovery of saprophytic and opportunistic gram negative pathogens such as *Pseudomonas spp*, *Klebsiella spp* and *Flavobacterium spp*¹⁴. The latter species are capable of thriving in low temperature and low nutrient environments including distilled water. Only *Pseudomonas aeruginosa* derived from DUW has definitely been shown to cause infection. Two patients with solid tumours were unwittingly exposed to DUW contaminated with *P. aeruginosa*. Both patients subsequently developed oral abscesses which pyocine typing confirmed were caused by the same strain isolated from the DUW¹⁵. Of particular concern are the primary respiratory environmental pathogens found in DUW that can cause pneumonia, milder flu-like respiratory infection and, less commonly, wound infections for example, *Legionella pneumophila*⁶ and *non-pneumophila spp* as well as *Mycobacterium spp* including *Mycobacterium avium*. *M. avium* can cause disseminated infection in HIV seropositive patients following ingestion and colonisation of the gut¹⁷. Numbers of non-tuberculous mycobacteria in DUW exceeded that of drinking water by a factor of 400¹⁸. High numbers of non-tuberculous mycobacteria may be swallowed, inhaled or inoculated into oral wounds during dental treatment with the potential for colonisation, infection or immunisation. Priming of the immune system by exposure to environmental non-tuberculous mycobacterium helps to maintain the anti-tuberculin immune response¹⁹. The true extent of the risk posed by non-tuberculosis mycobacteria in DUW to the immunocompromised patient has yet to be fully eluci-

Table 1 Types of organisms isolated from dental unit water.

Bacteria	Fungi	Protozoa
<i>Achromobacter xyloxidans</i>	<i>Phoma spp</i>	<i>Acanthamoeba spp</i>
<i>Acinetobacter spp</i>	<i>Penicillium spp</i>	<i>Cryptosporidium spp</i>
<i>Actinomyces spp</i>	<i>Cladosporium spp</i>	<i>Microsporidium spp</i>
<i>Aliccaligenes dentrificans</i>	<i>Alternaria spp</i>	<i>Giardia spp</i>
<i>Bacillus spp</i>	<i>Scopulariopsis spp</i>	
<i>Bacteriodes spp</i>		
<i>Caulobacter spp</i>		
<i>Flavobacterium spp</i>		
<i>Fusobacterium spp</i>		
<i>Klebsiella pneumoniae</i>		
<i>Lactobacillus spp</i>		
<i>Legionella pneumophila</i>		
<i>Legionella spp</i>		
<i>Micrococcus spp</i>		
<i>Moraxella spp</i>		
<i>Mycobacterium avium</i>		
<i>Mycobacterium spp</i>		
<i>Nocardia spp</i>		
<i>Pasteurella spp</i>		
<i>Proteus vulgaris</i>		
<i>Pseudomonas aeruginosa</i>		
<i>Burkholderia cepacia</i>		
<i>Streptococcus spp</i>		
<i>Staphylococcus aureus</i>		
<i>Xanthomonas spp</i>		

dated. Similarly, the primary pathogen acanthamoeba is recovered from DUW and biofilms¹⁴. They are reputed to cause amoebic keratitis in contact lens wearers who clean their lenses in tap water²⁰. It is unknown whether they present a risk in the dental setting but routine use of protective eye wear by both the dental team and patients should shield the eyes from any possible exposure.

Risks to dental surgeons

Considerable attention has focused on the plight of the susceptible patient but the clinical members of the dental team inhale aerosols generated by dental equipment on a daily and long-term basis. Unfortunately, in common with the public, working dentists also have increased susceptibility to infection due to underlying disease or drug therapy. Abnormal nasal flora in dental personnel has been linked to water system contamination²¹. Studies have indicated that the clinical dental team experience an increased prevalence of respiratory infections compared to the general population or their medical colleagues²². Employing PCR methodology *Legionella spp* have been detected in 68 per cent of DUW samples and *L. pneumophila* in 8 per cent. Comparable prevalence rates were observed in potable water samples but significantly from a public health standpoint none of the potable samples had counts of >10,000 *Legionella*/ml whereas 19 per cent of the DUW samples were in this category²³. High concentrations of *Legionella* are usually required to initiate infection. Rates of seropositivity for *Legionella* antibodies are demonstrably higher amongst dental personnel than in the general

population²³. Additionally, the magnitude of *Legionella* antibody titres correlated directly with the duration of time spent carrying out clinical work, suggesting that aerosols generated from DUW are the likely source^{24,25}. Conversely, a survey carried out by Central Public Health Laboratory, London found no evidence that previous dental treatment was a risk factor in patients with legionellosis²⁶. A single case of fatal pneumonia in a dentist from *L. dumoffi* has been reported. The evidence linking the disease to DUW is only circumstantial. *L. dumoffi* and other *Legionella* species were recovered from his surgery waterlines, although not from his domestic potable water supply²⁷. Unfortunately, the isolates were not available for molecular typing which would have confirmed the link to the source. However, the possibility still remains that DUW-associated infections have gone unrecognised or unreported because of the failure to associate exposure to DUW or aerosols with the development of specific infections. Sporadic infections not requiring hospital admission, such as Pontiac fever also caused by *Legionella*, are less likely to be investigated or notified to health authorities.

Approaches to risk reduction

Anti-retraction valves and retrograde aspiration of oral fluids

Early studies on DUW microbiology emphasised the presence of oral bacterial species (*Table 1*)⁸. The implicated source was re-aspiration of fluid from the oral cavity that occurs when negative pressure is generated on stopping equipment. Recently, molecular techniques

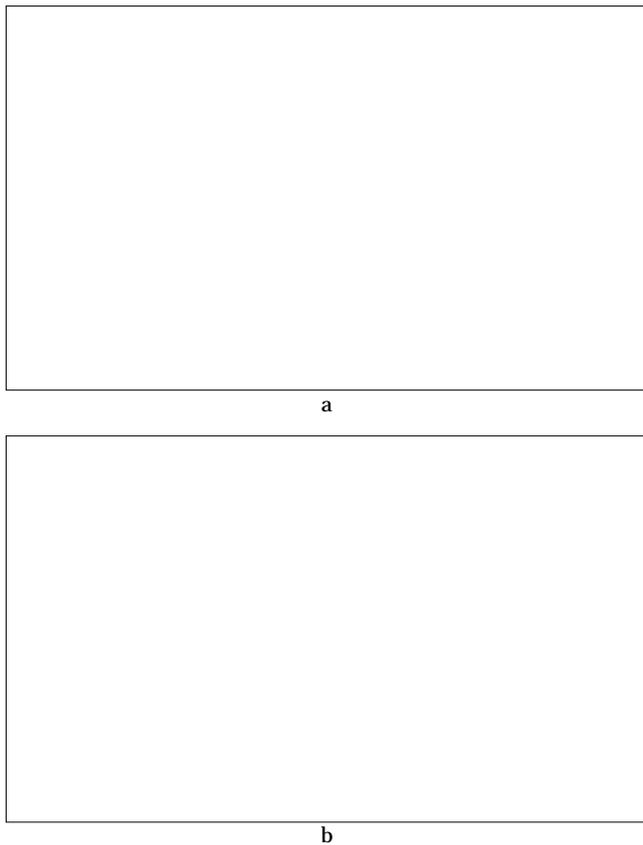


Figure 1

- a) Scanning electron micrograph of bacterial biofilm forming on the internal surface of a dental waterline; b) Scanning electron micrograph of the appearance of the biofilm after treatment with hydrogen peroxide which results in disruption of the surface of the biofilm. SEMs generously provided by SIRONA Dental Systems, Germany.
- a) Une micrographie par microscope électronique à balayage d'un biofilm microbien se formant sur la surface interne d'une conduite d'eau d'un unit dentaire; b) Micrographie par microscope électronique à balayage de l'apparence d'un biofilm après traitement avec de l'eau oxygénée, ce qui provoque une perturbation sur la surface du biofilm. Les microscopes électroniques à balayage ont été généreusement fournis par SIRONA Dental Systems d'Allemagne.
- a) Elektronenrastermikroskopaufnahme (SEM): mikrobielle Kontaminatin der Innenwand eines Wasserschlauchs – geschlossene Bakterien-schicht; b) SEM-Aufnahme: Schlauch-innenwand nach Wasserstoffperoxid-Behandlung, die einen zerrissenen Bakterienfilm hinterließ.
- a) Micrografía exploradora electrónica de la biopelícula bacteriana que se forma en la superficie interna de una línea de agua dental; b) Micrografía exploradora electrónica de la apariencia del biofilm después del tratamiento con peróxido de hidrógenos que resulta en la intercepción de la superficie del biofilm. Los SEMs (scanning electron micrograph) suministrados por SIRONA Dental Systems, Alemania.

were employed to demonstrate the recovery of viral particles and human DNA in waterlines servicing the air turbine and prophylaxis angle handpiece²⁹. Anti retraction valves (also known as check valves) will limit re- aspiration and are most efficacious when fitted immediately distal to the handpiece. As with any component of the water supply line they are subject to

clogging due to biofilm deposition and fatigue⁹. In order to ensure adequate mechanical functioning, they require regular maintenance and programmed replacement. Autoclaving of handpieces after use and flushing of units for 30 seconds at the end of patient treatment and for 2.5 minutes at the end of the day will augment the action of the anti retraction valve and should help to eliminate any aspirated fluid³⁰. Some manufacturers have incorporated anti-retraction valves within the handpiece design permitting autoclaving of the valve between patients. The American Dental Association (ADA), American National Standards Institute (ANSI) recommends that anti-retraction valves be installed on all dental water lines. Specifications for anti retraction valves have been produced by the American National Standards Institute/American Dental Association 1983.

Backflow from dental units to the mains water supply may occur and it may be necessary to install check-valves to prevent this occurring³¹. There is little evidence to support this notion as low colony counts at drinking water concentrations are recovered from the plumbing to the water faucets in the dental surgery. However, dentists are required to comply with locally enforced water supply and sewage regulations.

Filtration

Using filters on the dental waterline to eliminate bacteria from the water entering the handpiece was first described 20 years ago to reduce planktonic bacteria³². Both the original and more recent publications demonstrated that high levels of recontamination of DUW occurs within 24 hours as a result of trapping and growth of bacteria on the filters³³. Therefore disposable filters are recommended, which must be changed daily³⁴. For maximum efficiency, filters should be inserted just distal to the point of entry of water into the handpiece. A pore size of 0.2 microns is recommended (US Federal Drug Administration). Designs with pleated filters have a larger surface area for filtration. Only minimal reductions in flow rate are experienced and are unlikely to be noticeable in practise. Filters have no impact on biofilm formation. While disposable filters are a promising method of improving water quality their clinical effectiveness has not yet been fully established. Nevertheless, prevention of planktonic bacteria from entering the handpiece from the waterline will reduce patient exposure to harmful pathogens. Filters should also reduce retrograde contamination.

Flushing

The Communicable Disease Centre's, American Dental Association's and British Dental Association's recommendations for control of DUW contamination, all state that water lines should be flushed through for 'several minutes' at the start of each clinic day to substantially

reduce microbial accumulation caused by overnight stagnation in the waterlines⁷. Furthermore, in order to minimise exposure to aerosols the procedure is best performed in conjunction with high velocity evacuation into an enclosed container. Discharging the stagnant water improves the perceived quality of the water and reduces the malodour and bad taste imparted to the water by microbial contamination. It will also draw through low concentrations of chlorine (0.1 to 0.5ppm) normally present in mains water. However, it is recognised that flushing provides only temporary reductions in bacterial load and has no effect on the biofilm. As a result of the physics of the laminar flow in the waterline, the layer in immediate contact with the biofilm is stationary even during flushing. The effectiveness of flushing has been challenged by a number of authors who report bacterial clearance was both variable and minimal when used for short periods of time (<10 min)³⁵⁻³⁷ and in one report actually increased post-flush³⁸. In most studies bacterial load was not consistently reduced to the desired standard of less than 200 cfu/ml, unless extended flush times were employed³⁶. Flushing for 20 minutes, which would be impractical in most dental surgeries, will reduce the bacterial count to zero³⁵. However, the persistent nature of the contamination is demonstrated when 30 minutes later, shedding of bacteria from the biofilm returns the total colony counts to within the pre-flush range³⁶.

Flushing was introduced as a simple and expedient measure, that could be instituted immediately as a stop-gap procedure in all dental surgeries of whatever age or type, without the need to purchase additional equipment. As described above flushing is valuable in eliminating retrograde aspiration of oral fluids.

Biocides and chemical disinfectants

Biocides (compounds with lethal activity against living organisms) have been used in an attempt to remove the biofilm and eliminate the planktonic bacterial count and their use has met with a limited degree of success. These include chlorhexidine gluconate³⁹, povidine iodine⁴⁰, ethanol⁴¹, hypochlorite⁴², peroxide⁴³ and glutaraldehyde¹⁰. The intrinsic resistance of the biofilm ecosystem has hampered their value. Ideally, biocides require a broad spectrum of anti-microbial activity, to be non-toxic to individuals and non-pollutant to the environment. In certain States in the USA there are restrictions on dental surgeries discharging their waste water into the municipal sewage system because of the fear of chemical pollution.

Chlorination

Chlorine, as sodium hypochlorite, is the most commonly employed biocide in water treatment plants and has proven efficacy in cold water hospital systems, in

particular in controlling *Legionella* proliferation⁴⁴. Chlorine can be added to the water at the central supply intake. This approach is mainly applicable to larger multiple surgery practises or in Dental Hospitals and universities. Independent reservoir clean water systems can also be used to deliver chlorine flushes to the dental water line. The system can be 'shocked' or hyperchlorinated intermittently with high doses of 50ppm chlorine every 6 months. Alternatively a continuous chlorination system can be installed, with an automatic dosing mechanism providing 1ppm chlorine at the chair. Chlorination was found to be effective in maintaining drinking water standards in the storage tank and distribution pipes³³. Equivocal results have been obtained from measurements of DUW with some studies reporting bacterial counts reduced to a few hundred⁴² and others finding only temporary remission in contamination and no elimination of *L. pneumophila*³³. When legionellae are sequestered within free-living amoebae there is a 30–120-fold increase in chlorine resistance, thus explaining the failure to eradicate the organism from the system⁴⁵.

Resistance to biocides will develop in the bacterial population with extended exposure. Potentially, higher doses of 3–5ppm could overcome these problems, but high chlorine levels are unpalatable, and long term corrosion damage occurs with free residual chlorine levels as low as 1ppm³³. In addition, high levels of chlorine are associated with *in vitro* formation of trihalomethanes, which are recognised as potential carcinogens⁴⁶. However, these problems apply to chlorinated water for clinical use. Higher doses could be used in the independent water systems as a flush to remove planktonic bacteria, as the apparatus is purged of chlorine before patient use. Corrosion of metal components would still be a problem.

Glutaraldehyde is available for use with an integral, automated flush system with a contact time of 7 minutes¹⁰. Glutaraldehyde is a highly effective disinfectant with bactericidal action against most vegetative bacteria, mycobacteria and viruses but its sensitisation of the human lung and skin have severely limited the use of this compound in dentistry except in situations where exhaust ventilation can be assured.

Bacteria within the biofilm pose a major stumbling block to the use of biocides. They are 3,000 fold less susceptible to hypochlorite and so they are not readily degraded even by concentrated solutions of bleach or of other disinfectants such as glutaraldehyde. Planktonic organisms will be destroyed but even if the majority of the organisms in the biofilm are eliminated the architecture of the biofilm survives and acts as a pre-formed matrix for renewal of the biofilm. Inactivation of biocides is further impaired by interaction with organic material and electro-repulsion caused by surface charges on the biofilm. For the future, 'electro-enhancement' of biocides producing neutralisation of the surface charge may be incorporated into medical equipment to resolve the problem of build up of biofilm⁴⁷.

Peroxide, ozone and ultraviolet light

Other compounds that can be introduced continuously, into the water lines during patient treatment are hydrogen peroxide and ozone⁴³. Such measures have the advantage of maintaining low levels of planktonic counts throughout treatment which during complex restorative procedures may be prolonged. Bacteria from the biofilm are shed continually while the film is in contact with water.

Hydrogen peroxide has been used in dentistry as a bleaching agent, and root canal irrigant as well as in dentrifices and mouthrinses. It has found favour as a disinfectant (7 per cent solution) for flexible endoscopes where the efficacy was found to be comparable with that of 2 per cent glutaraldehyde and in the disinfection of contact lens cases where it was reported to be more effective against biofilms^{48,49}. Unfortunately, the published efficacy data on hydrogen peroxide and ozone with regard to purification of DUW is limited at the present time. An FDA approved delivery system for hydrogen peroxide is commercially available which provides metered, microprocessor controlled, continuous release of stabilised peroxide into the water line.

UV treatment of water has been used alone and in conjunction with ozone and other biocides for control of legionellae and reduction of endotoxins in water cooling towers and water treatment plants, for example for swimming pools. UV would appear to be an attractive, non-polluting alternative for point of entry of mains water purification. However, evidence that UV irradiation alone has a significant effect on reducing microbial contamination is equivocal due to the relative resistance of some important waterborne pathogenic species⁵⁰.

A major advantage of these systems is that they avoid introducing chemical disinfectants into the effluent water system with the potential for pollution and destructive effects on wildlife.

Independent clean water systems

Introducing sterile water rather than contaminated mains water into the system even if the concentration of organisms is low in the mains water is a logical first step in initiating a clean if not sterile chain for DUW delivery. Changes in weather patterns due to global warming have resulted in extremes of rainfall from droughts to flooding. Both situations can cause contamination of the municipal water supply due to backflow into the mains of floodwaters or of stagnant water from leaks from piping that becomes depressurised when the distribution system is cut off. Dentists need to be able to maintain a constant source of safe water during periods of interruption to the municipal water distribution system arising from emergency introductions of boil notices, drought orders, standpipes or rota cuts⁵¹. A separate, pressurised clean water reservoir system filled with sterile water plumbed to the water lines, bypasses the mains connections to the municipal water, providing a

suitable alternative¹⁰. Reservoir systems also comply with water distribution by-laws which state that dental units should be isolated from the incoming mains water supply by incorporation of an air gap in the system thus preventing back-siphonage. This approach has a long history of military use in field surgeries when armies are on manoeuvres.

The cost of fitting clean water systems is approximately £200 (US\$320). The total volume of water consumed per day as an irrigant is in the range of 1–2l/dental unit, thus the use of a small reservoir is feasible and convenient. Reservoirs should be used preferably with sterile water or boiled water that is allowed to cool in a sterile sealable container¹⁰. Water bottles need to be handled with care as the water can become contaminated with skin organisms. Water adapted organisms such as the opportunistic pathogens *Pseudomonas aeruginosa* and *Burkholderia cepacia* (causative agent of pneumonia in cystic fibrotic patients) are able to survive for long periods in distilled water⁵². These systems are capable, if used correctly, of delivering a high quality water supply, but not sterile water, if they are installed on existing biofilm contaminated water lines⁵³. The design is dual purpose and can be used for both water delivery and regular purging of water lines with disinfectant. In order to maintain planktonic counts at a minimum the waterlines need to be routinely disinfected (either daily or weekly) according to manufacturers' instructions with a suitable diluted disinfectant such as sodium hypochlorite or hydrogen peroxide for 10 minutes then flushed thoroughly with sterile water^{34,53}. Contamination of the system can still occur due to suck-back of oral fluids through faulty anti-retraction valves and a 30 second flush between patients is still mandatory. Letting the system drain down to dry and purging with air or ethanol will help to prevent biofilm proliferation due to desiccation.

Autoclavable systems

In response to the evolving high standards for quality control and prevention of DUW contamination, a fully autoclavable assembly of water reservoirs, silicon multi lumen dental unit waterline tubing and fittings to be sterilised between patients has been produced and has been cleared for marketing by the Food and Drug Administration, in the USA¹⁰. Such devices should, if manufacturers' instructions are fully adhered to, remain free from biofilm build up, as any contamination from retrograde aspiration or from skin organisms during manipulation should be destroyed during autoclaving. Autoclavable systems may be the solution to providing secure, sterile water systems.

Conclusions

Since the origins of dental unit water contamination are now more clearly defined, substantial progress can be

made by dental manufacturers and the scientific community in approaches to prevention and control. Due to the multiple ports of entry to the DUW system for microbes, no single method or device will completely eliminate the potential for cross infection. Combinations of currently available procedures and equipment, including antiretraction devices, flushing, independent water supplies used in conjunction with biocide purges or fully autoclavable water line circuitry should provide water which is of a higher standard than that of drinking water. All these systems require strict adherence to maintenance protocols to perform to their full potential. Chairside devices for monitoring microbial quality of the DUW need to be developed and are an essential component to assure satisfactory water quality. Future research into the prevention of biofilm proliferation is being actively promoted by the American Dental Association and other dental organisations and government agencies around the world.

Recommendations

- No currently available single method or device will completely eliminate contamination of DUW or prevent the risk of cross infection. Future develop-
- ments in DUW technology that prevent biofilm development or employ single use systems are eagerly awaited. Until such time a combination of methods will need to be employed.
- Water supplying dental units should have a total colony count of <200 cfu/ml and comply with local drinking water standards for indicator organisms
- Where water is used as a handpiece irrigant in surgical procedures, sterile water or saline should be provided from a separate, and preferably single use source which cannot be contaminated by passage through the dental unit waterlines.
- Existing recommendations for flushing through of water lines between patients and at the beginning and end of the working day is a useful method to eliminate oral flora entering the waterlines via suck-back.
- Anti-retraction valves should be fitted on all handpieces and must be regularly monitored and maintained.
- Independent water reservoirs avoid dependence on the use of municipal water supplies, and when used with sterile water are capable of delivering water with <200 cfu/ml total count. This can only be achieved if manufacturer's instructions regarding disinfection are adhered to. They can also be used to purge the waterlines with a biocide.



La contamination microbienne des conduites d'eau des unités dentaires ; l'argument scientifique

Résumé

La qualité de l'eau de l'unité dentaire est d'une importance considérable, car les patients et les membres de l'équipe dentaire y sont régulièrement exposés, ainsi qu'aux aérosols provenant des unités dentaires. La caractéristique unique des conduites d'eau du fauteuil dentaire est sa capacité à développer rapidement un biofilm sur les conduites d'approvisionnement en eau, auquel s'associe la formation d'aérosols potentiellement contaminés. Le biofilm provenant des bactéries à l'arrivée de l'eau qui est intrinsèquement résistante à la plupart des biocides, devient alors un réservoir primaire pour une contamination permanente du système. L'eau de l'unité dentaire peut alors être fortement contaminée par des agents pathogènes respiratoires opportunistes, tels que la *Legionella* et le *Mycobacterium* spp. L'article discute de l'importance d'un tel contact pour les patients et l'équipe dentaire. Il n'a pas, à l'heure actuelle, été prouvé qu'un problème de santé publique de grande envergure existait pour cause de contact avec l'eau des unités dentaires. Néanmoins, l'objectif du contrôle de l'infection est de minimiser le risque de contact avec des agents pathogènes potentiels et de créer un environnement de travail sans danger dans lequel les patients peuvent être traités. Cet article évalue l'éventail des méthodes de contrôle de l'infection et des stratégies de prévention actuellement disponibles, destinées à réduire l'importance du biofilm sur la contamination de l'eau dentaire et pouvant être utilisées en exercice général. La charge microbienne dans l'eau de l'unité dentaire peut être conservée en-dessous ou au niveau stipulé pour l'eau potable (moins de 200 unités formant une colonie par ml), en utilisant une combinaison de mesures facilement disponibles et en observant strictement les protocoles d'entretien. Il faut utiliser de l'eau stérile pour tous les traitements chirurgicaux.



Mikrobielle Kontamination von Wasserschläuchen in Zahnarztpraxen: eine wissenschaftliche Argumentation

Zusammenfassung

Die Qualität von Wasser aus Schläuchen an Behandlungseinheiten stellt sowohl für die Patienten als auch das Praxispersonal eine zentrale Frage dar, da sie unmittelbarem – und im Falle der Helferinnen – regelmäßigem Kontakt ausgesetzt sind. Wasserschläuchen droht aufgrund ihrer 'Anatomie' erhöhte Kontaminierungsgefahr infolge der Ansiedlung von Bakterien an der Schlauchinnenwand. Eine zusätzliche Gefahrenquelle stellt die Erzeugung potentiell kontaminierter Aerosole dar. Die Bakterien, die sich in dem in den Schlauch eintretenden Wasser befinden, weisen eine immanente Resistenz gegenüber antibakteriellen Mitteln auf, wodurch die Gefahr der fortgesetzten Systemkontamination besteht. Opportunistisch-pathogene Erreger der Atemwege wie bspw. *Legionella* und *Mykobakterien* spp, können stark kontaminierende Wirkung haben. In dem Beitrag werden die möglichen Folgen einer Exposition für Patienten und Praxismitarbeiter diskutiert. Meldungen, daß bereits ein flächendeckendes öffentliches Gesundheitsproblem aufgetreten ist, liegen bis dato nicht vor. Infektionsschutz soll vorbeugen und zur Minimierung der potentiellen Belastung infolge Exposition sowie zur Schaffung einer für Personal und Patient sicheren Behandlungsumgebung beitragen. Bewertet werden die derzeit allgemein bekannten Infektionsschutzmaßnahmen und Präventionsstrategien, die das Risiko der Wasserkontamination aufgrund von Bakterienbesiedlung im Innern von Schläuchen so weit wie möglich reduzieren sollen. Die bakterielle Belastung des Wassers kann auf oder unter dem für Trinkwasser empfohlenen Niveau (weniger als 200 kolonienbildende Einheiten/ml) liegen. Hierzu ist die Verwendung einer Maßnahmenkombination sowie die strikte Befolgung von Wartungsanleitungen erforderlich. Nicht zuletzt sollten bei allen dentalchirurgischen Eingriffen grundsätzlich sterile Wasserreserven benutzt werden.



Contaminación microbiana de las unidades de agua dentales: el argumento científico

Resumen

La calidad del agua de la unidad dental es de suma importancia ya que los pacientes y el personal dental están regularmente expuestos al agua y a aerosoles de la unidad dental. Una singular característica de los conductos de agua del sillón dental es la capacidad de formación rápida de una biopelícula sobre los conductos de suministros dentales de agua en combinación con la generación de aerosoles potencialmente contaminados. La biopelícula, que se produce de la bacteria en el agua entrante y que es intrínsecamente resistente a la mayoría de las biocidas, se convierte luego en el depósito principal de la continua contaminación del sistema. El agua dental puede contaminarse con patógenos oportunistas respiratorios como el de *Legionella y ycobacterium* spp. En este trabajo se discute lo que significa la exposición para el paciente y el equipo dental. No existe en estos momentos evidencia de un problema serio a nivel de la salud pública de la exposición a la unidad de agua dental. No obstante, el objetivo del control de la infección es el de minimizar el riesgo de la exposición a patógenos y crear un ambiente de trabajo seguro para el tratamiento de los pacientes. Este trabajo considera la gama de los métodos de control de la infección actualmente disponibles y las estrategias de prevención cuya finalidad es reducir el impacto de la biopelícula en la contaminación del agua dental, y que son de uso apropiado en la práctica general. La carga bacteriana en la unidad de agua dental puede ser conservada a, o por debajo, de las directivas que se recomiendan para el agua potable (menos de 200 unidades formadoras de colonias por ml), utilizando una combinación de medidas fácilmente disponibles y respetando estrictamente los protocolos de mantenimiento. En todos los procedimientos quirúrgicos se deberá emplear agua estéril.

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