Tiger of a different stripe

ORAL CAVITY PROPERTIES THAT ALTER INFECTION RISK

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If the presence of blood indicates a likely breach of sterile tissue, why isn't a dental operatory considered a procedure room? Why isn't a sterile field required for routine dental procedures? Why isn't the ventilation configured to meet the requirements of a sterile environment?

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Staphylococcus aureus and the oral cavity: An overlooked source of carriage and infection? McCormack MG, Smith AJ, Akram AN, et al. *Am J Infect Control,* Vol. 43, Issue 1, p35–37.

Evaluation of an ethical method aimed at improving hygiene rules compliance in dental practice. Offner D, Strub M, Robert C, et al. *Am J Infect Control,* Vol. 44, Issue 6, p666–670.

If you have these same questions, or maybe you haven't really explored the nuances of a dental environment regarding infection control, you are not alone. Accreditation focus is increasing in dental infection control, and dental clinics are being held to the same infection control standards and guidelines as medical environments. However, there are significant differences between the dental environment and the medical environment regarding the understanding of healthcare-associated infections (HAIs) and how to control them. The infection preventionist (IP) would be well-equipped to know these differences and to know the accreditation requirements.

Dental HAIs have not been clearly defined and differ from medical definitions that include "breach of sterile tissue" as a fundamental requirement for most parenteral infections. The oral environment, on the other hand, has gradations of mucosal tissue abrasions and breaches, where there is no clear "breach" of sterile tissue. Further, saliva has known immunological properties as well as physical-chemical properties that exert a protective effect against infection (see Figure 1). These oral cavity characteristics should drive a different approach for dental HAI surveillance and follow-up protocols, but there is little guidance on how surveillance in the dental environment should be conducted, or how follow-up protocols should be standardized. This article seeks to present key differences between the oral environment and the sterile tissue environment and how those differences impact the practice of infection control.

ORAL MICROBIOLOGICAL AND IMMUNOLOGICAL ENVIRONMENT

As with all surgeries, dental personnel and patients have the potential for exposure to bacterial, fungal, and viral organisms. Therefore, the use of personal protective equipment (PPE) is required and proper sterilization protocols are used for reusable instruments. But, in contrast to other surgical sites, special characteristics of the oral environment create subtle yet important differences when it comes to infection prevention and control (IPC) for providers and patients.

From an IPC perspective, the oral cavity has several features that make it different from any other area of the body. To begin with, there are approximately 500–1,000 different species of bacteria and multiple species of fungi that make up the normal flora of a healthy oral cavity.[1] A sterile environment has none. Thus, it is impossible to create a strict

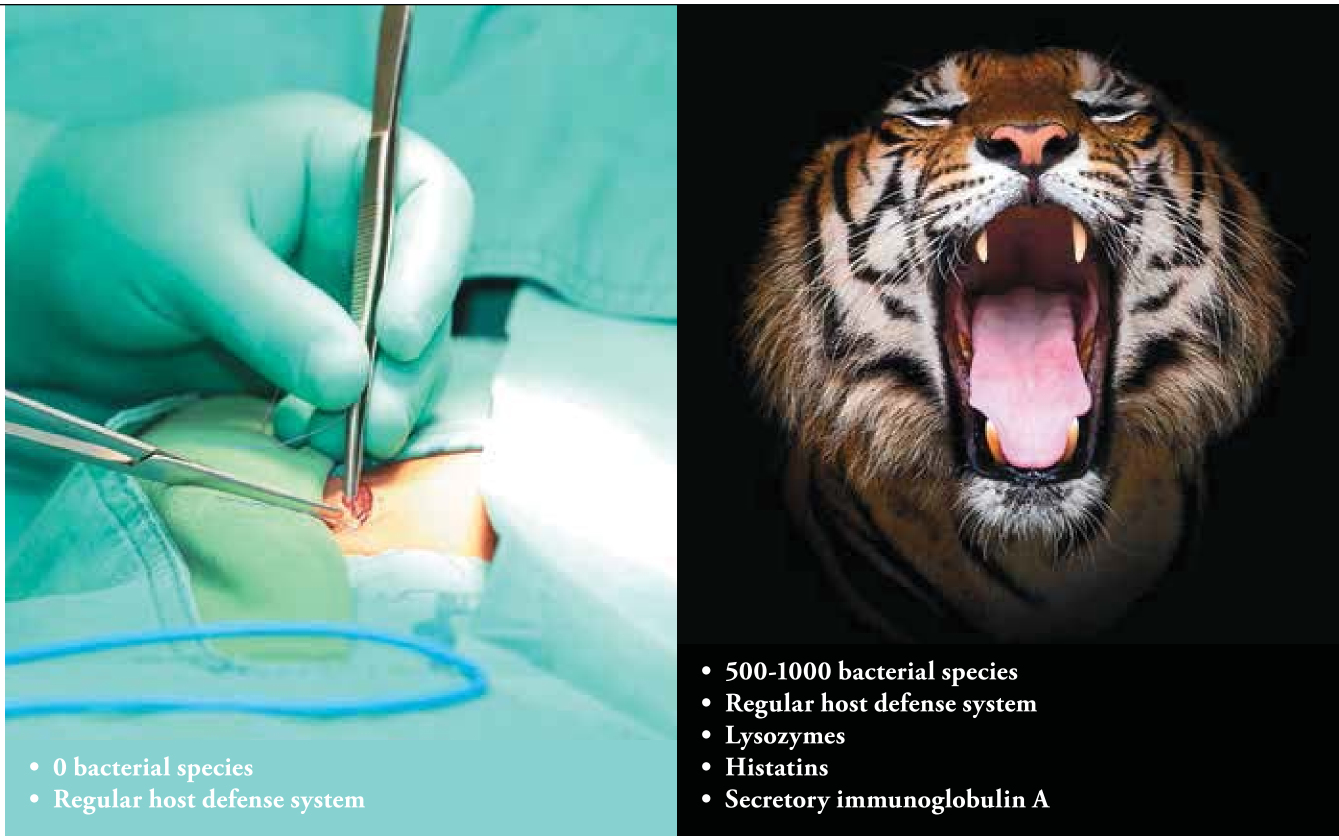

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Figure 1. Comparing the oral environment to sterile tissue breach.

sterile environment when performing any dental procedure compared to performing a general surgery.

Another major factor that sets dental infection control apart is the unique micro-immune system that exists in the mouth. According to the seminal text on the topic, *Molecular Oral Biology*, oral bacteria that occupy the ecological niche provided by both the tooth surface and gingival epithelium have evolved mechanisms to sense their environment and evade or modify the host. A highly efficient host defense system constantly monitors microbial colonization and prevents invasion of local tissues.[2] The primary component of this defense is saliva and its constitution, which allows for a unique functionality of the mouth when it comes to surgical site healing and resistance to infection. Salivary fluid has been shown to decrease clotting time compared to other areas of the body by salivary proteins neutralizing anticoagulant factors in the blood.[3] Saliva also has many antimicrobial properties preventing general infection. The most prominent immunologic in saliva is secretory immunoglobulin A (IgA), which has shown to neutralize pathogenic microorganisms and prevent adhesion.[4] IgA, accompanied by lower levels of other antibodies, provides a robust adaptive immunological barrier to infectious organisms in the mouth. In addition, there are many non-immune immunologic components of saliva that add to the immunologic protection it provides. Specifically, lysozyme enzymes and histatin proteins are present in high quantities that damage critical components of infectious organisms leading to cell death.[5] Clinically, the composition of the oral environment and the functionality of saliva results in healing and the absence of infection that is not typically seen in other areas. The vast majority of intraoral surgical site incisions will heal by primary intention; thus, sutures are not required nor do scars develop. Furthermore, intraoral post-operative surgical infections are rare, even in the presence of co-morbidities or medications that affect immune function.

When the public thinks of a surgery they envision a trip to a hospital operating room where they will be sedated and cut open. This perspective describes an invasive procedure. By definition, a medical procedure is invasive when a break in the skin or mucosa is created and there is contact with the non-intact skin, mucosa or internal body cavity beyond a natural or artificial body orifice. This seems self-explanatory but becomes much more complicated when comparing the mouth to the rest of the body. If going strictly by the above definition, almost all dental procedures would be considered invasive including routine fillings and cleanings because they involve creating a break in tissues, enamel in the case of a filling and the gingival mucosa in the case of the majority of cleanings. Most people would not consider teeth cleaning an invasive surgery, but why not? The answer is not actually in the manipulation of tissues because this occurs whether having a tooth extracted or an appendix removed, but in how our bodies at large react to surgeries and how that differs in the mouth. As previously discussed, the mouth is equipped with its own unique immune system that is a combination of innate, adaptive and mechanical immunological processes that make the oral cavity resistant to local site infections and a barrier to systemic infections. However, very

Surgical infection control	Joint replacement surgery	Dental implant surgery
Pre- surgical shower with antibacterial soap	Yes	No
Pre-surgical antibiotics	Yes	No
During surgery antibiotics	Yes	No

Table 1. Comparing infection controls between medical and dental procedures.

little data exist to support these facts. In a system with financial limits, as is the case with dental practice, it is not prudent to invest a significant amount of resources to something such as dental infections that simply do not occur with any type of consistency to affect patient outcomes. For example, well-researched and defined IPC precautions exist between a joint replacement procedure and the placement of a dental implant. However, both involve incision and displacement of soft tissues, exposure and removal of bone and placement of a prosthetic device in that bone. The differences in IPC precautions are shown in Table 1. Because of the similarities of prosthetic joint placement and a dental implant, pre-operative antibiotic prophylaxis has been suggested for both. However, strong evidence exists that pre-operative antibiotics have little, if any, effect on post-operative dental implant infections.[6] This illustrates the need for more research to definitively illustrate why these differences occur.

DENTAL UNIT WATERLINE RISK

As for meaningful infection risks in the dental environment, waterline biofilm is a likely one. Even in the presence of the protective nature of the oral cavity dental unit, waterlines have been identified as the certain cause in a few documented infections. As such, there has recently been a heightened focus on dental waterlines and the potential risks that they may bring to dental patients. The Centers for Disease Control and Prevention (CDC) has found that there are more than 200 species of microorganisms cultured from dental unit waterlines. The CDC has randomly tested dental unit waterlines and found that colony counts of some of these waterlines have been 400 times higher than their local water source. Colony counts from untreated waterlines can exceed 1,000,000 CFU/mL. There have been a wide range of microorganisms that have been isolated from dental unit waterlines, including protozoa, free-living amoebae, fungi, and nematodes. There have been human pathogens detected as well, such as *Legionella pneumophila,* Mycobacteria species, *Pseudomonas aeruginosa,* and *Staphylococcus* species.[7,8]

Lately there has been a growing connection between dental patients' illness, infection and fatalities in connection with dental unit waterlines. In 1995, a 65-year-old orthodontist died after developing pneumonia caused by *Legionella. Legionella* was later isolated from a dental unit waterline.[9] In 2011, an 82-year-old woman died after contracting pneumonia which was traced back to a contaminated dental unit waterline.[10] In 2015-16, there were multi-patient outbreaks of non-tuberculous aquatic *Mycobacteria* in pediatric dental practices in Georgia and California. All infected children at both locations underwent pulpotomy treatment, and all cases were traced back to improperly treated dental unit waterlines. In 2016, 20 patients from another Georgia practice were confirmed to be infected with *Mycobacterium abscessus (M. abscessus).* All 20 patients were severely ill, requiring at least an average of seven days in the hospital. Seventeen patients required surgical excision and 10 received outpatient intravenous antibiotics. All water samples from seven dental units had more than 500 colony-forming units (CFU/ml) with the average being (91,333 CFU/mL). *M. abscessus* was detected in all water samples.[11,12,13]

The Environmental Protection Agency (EPA) microbiologic standards for drinking water are having a heterotrophic plate count of no more than 500 bacterial colonies per milliliter with 99.9 percent of *Giardia lamblia* and viruses killed/inactivated. In 1993 the CDC recommended that dental unit waterlines should have less than 500 CFU/mL of bacteria, while more recently the American Dental Association (ADA) has come out with the recommendation of 200 CFU/mL.[14]

Protecting patients from infections caused by dental unit waterlines is a three-fold process. It takes a successful dental unit waterline set up, proper monitoring, and proper treatment of the dental unit waterlines. First, you need a dental waterlines system that is updated and avoids designs that can contribute to waterline contamination. Due to the small tubing, dental unit waterlines are conductive to rapid formation of biofilm. Some characteristics to avoid when designing a dental unit waterline are long lengths of narrow-bore tubing, dead legs, gauges, control blocks, and valves. Dental unit waterline water quality can be monitored by either in-office chairside testing or laboratory testing. There are two main types of chairside testing methods. They are heterotrophic plate counts and microorganism cultures. Convenient kits are available for either of these methods. Advantages to chairside testing kits are that they are convenient and easy to use. Disadvantages to these methods include underestimation of counts and certain phenotypes of

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INFECTION PREVENTION CONTROLS USED IN DENTAL SETTINGS
Standard Precautions and Personal Protective Equipment
Engineering and Work Practice Controls
Hand Hygiene
Operatory Turn Around / Housekeeping policies and procedures
Instrument processing policies and procedures Dental unit waterline maintenance and disinfection
Management of Infectious Waste policies and procedures
Laundry policies and procedures
Hepatitis B Vaccination policy and procedures to include vaccine and titer testing at no cost to employees
Post-exposure evaluation and follow-up policy and procedures

Table 2. Basic infection controls in the dental environment.

bacteria fail to grow. Laboratory testing may produce more accurate results and give you a third-party confirmation to the test, but will end up costing more and may take longer to get the test results. The frequency of water testing should be according the manufacture instructions of the treatment system that you are using. This may be once a year, once a quarter, once a month, or once a week. There are a variety of chemical treatment options for dental waterlines. They include hydrogen peroxide, pure iodine, silver ions, chlorine dioxide, ozone, sodium hypochlorite, peracetic acid, and chlorhexidine gluconate.[15-17]

INFECTION CONTROL SURVEILLANCE, STANDARDS, AND PRACTICES

Though uncertainty exists regarding the level of HAI risk within the dental environment, regulatory risk is high given the many oversight organizations to which clinics are accountable. These organizations and their requirements include the following: states' Dental Practice Act licensing requirements, Accreditation Association for Ambulatory Health Care (AAAHC) and The Joint Commission (TJC) healthcare facility accreditation standards, Occupational Safety and Health Administration (OSHA) regulations, Centers for Medicare & Medicaid Services [CMS] regulations, CDC guidelines, and the ADA guidelines. The basic controls required in dental environments are summarized in Table 2.

Two primary sets of requirements specifically pertaining to infection control that are particularly scrutinized by accreditation organizations such as the AAAHC and TJC are the American National Standards Institute (ANSI)/Association for the Advancement of Medical Instrumentation (AAMI)/ST79:2017, "Comprehensive guide to steam sterilization and sterility assurance in health care facilities," and CDC's Guideline for Infection Control in Dental Clinics. Further, the legal requirements in OSHA's Bloodborne Pathogen Standard (29 Code of Federal Regulations 1910.1030) are always under scrutiny.

While ANSI/AAMI ST79:2017 sets forth the primary standards for table-top sterilization processes, it becomes rather onerous for dental clinics when it comes to ventilation requirements and storage of sterilized instruments. Many dental clinics opt to follow ANSI/AAMI ST79:2017 for table-top sterilization pre-cleaning, cleaning, wrapping, sterilizing, and monitoring, but choose to adopt the CDC's Guideline for Infection Control in Dental Clinics for ventilation and storage requirements. In either case, dental personnel who sterilize instruments must be qualified and provided with ongoing training, according to the CDC Guidelines.[8] To show that personnel are "qualified," accreditation surveyors generally want to see recurring competency assessments, usually performed annually.

Surveillance of dental procedure HAIs is becoming more common, but very little historical data exists other than those suggesting waterline contamination and biofilm composition can lead to HAIs. This is almost certainly because, as previously stated, waterline contamination is the only area in dentistry that has created enough public risk to drive research. Because of this lack of scientifically validated factors contributing to HAIs in dentistry, surveillance protocols are not fully developed. Therefore, follow-up protocols mainly involve monitoring the patient for a developing infection after certain, not all, particularly invasive procedures.

STANDARD PRECAUTIONS IN THE DENTAL ENVIRONMENT

Standard precautions in the dental setting are required, just as in any environment where blood, body fluids, nonintact skin, and mucous membranes exist. Since saliva has always been considered a potentially infectious material, mask, gloves, gown, and eye protection are required for the protection of the dental employee. Uncertainty exists, however, regarding when to change the gown. In the medical environment, clearly the gown must be changed between patients, but in the dental environment, given the oral properties that reduce infection risk, there is no evidence that changing gowns between patients is necessary to reduce infection risk to the patient, unless the patient is already under contact precautions and undergoing an emergency dental procedure. The CDC states the following, with the intent of protecting the employee: "[Dental personnel] should change protective clothing when it becomes visibly soiled and as soon as feasible if penetrated by blood or other potentially infectious fluids. All protective clothing should be removed before leaving the work area."[8] The CDC Guidelines and OSHA Bloodborne Pathogen Standard should be consulted for more information on employee protection.

CONCLUSION

Given the altered infection risk driven by the oral environment host defenses, controversy exists regarding the extent to which dental clinics need to follow some of the established standards and guidelines. In terms of HAI risk, one size does not fit all regarding the type of environment in which procedures take place, specifically the oral environment versus a sterile field, yet there are myriad laws, standards, and guidelines that are required to be followed even if some of them are not appropriate for the altered level of HAI risk in the dental environment.

Current scientific literature lacks a complete treatment of dental environment HAIs and appropriate controls. This paper is a call for further scientific investigation regarding rates of infection and exposure characteristics of HAIs in the dental environment. With additional knowledge, control methods can be modified to be specific for the dental environment, thus preventing overly burdensome requirements that might very well result in unintended consequences and increased accreditation risk.

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