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Infection Prevention:

Environmental Surfaces, Dental Unit Waterlines *and* Evacuation Lines

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2 CE Credits

Written for dentists, hygienists and assistants

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ABSTRACT

The treatment of environmental surfaces and dental unit waterlines (DUWLs) is required as components of adequate infection prevention. Environmental surfaces include both clinical contact and housekeeping surfaces. Clinical contact surfaces must be treated with barrier protection or cleaned and disinfected for each and every patient, in accordance with guidelines, to prevent indirect transmission of microorganisms and disease. If barrier protection becomes compromised, the surface must then also be cleaned and disinfected. DUWLs and evacuation lines must be treated on a daily basis. At the end of each day, evacuation lines must be flushed with a cleaner that will help reduce debris and microorganisms.

EDUCATIONAL OBJECTIVES

The overall objective of this article is to provide the reader with information on appropriate infection prevention protocols for environmental surfaces, dental unit waterlines and evacuation lines. On completing this article, the reader will be able to do the following:

1. List and describe the manner in which environmental surfaces may become contaminated and contribute to the chain of infection;
2. Review the methods by which housekeeping and clinical contact surfaces can be cleaned and disinfected, as well as associated considerations;
3. List and describe the role of dental unit waterlines in cross-contamination and the transmission of microorganisms, and procedures that must be followed; and,
4. Delineate the role of evacuation cleaners, their use and considerations in their selection.

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Dr. Fiona M. Collins has authored and presented CE courses to dental professionals and students in the United States and internationally, and has been an active author, editor, speaker and consultant in the dental industry for several years. Fiona is a member of the American Dental Association, the ADA Standards Committee working groups, Chicago Dental Society, and the Organization for Safety, Asepsis and Prevention (OSAP). She is the ADA external representative to AAMI, a member of OSAP, the British Society of Dental Hygiene Therapists Publications Committee, and a Fellow of the Pierre Fauchard Academy. Dr. Collins earned her dental degree from Glasgow University and holds an MBA and MA from Boston University. AUTHOR DISCLOSURE: Dr. Collins has received honoraria from several infection control companies, including Sultan Healthcare. Dr. Collins can be reached at fionacollins@comcast.net

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Infection Prevention:

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The Chain of Infection

In 2003, the Centers for Disease Control and Prevention (CDC) published "Guidelines for Infection Control in Dental Health-Care Settings – 2003."[1] This followed the Standard Precautions issued by the CDC in 1996, which state that all body fluids (except sweat), mucous membranes and open percutaneous wounds are regarded as potential sources of pathogens. Infection prevention guidelines and a series of steps must be followed for infection prevention and in accordance with OSHA regulations. The chain of infection requires that a reservoir or source be present for a pathogen at a level sufficient to result in infection. A member of the clinical team, a non-operatory dental healthcare worker or a patient may be a source/reservoir. Inanimate objects such as contaminated operatory surfaces or instruments may also serve as reservoirs or sources that provide a means for the spread of microorganisms.

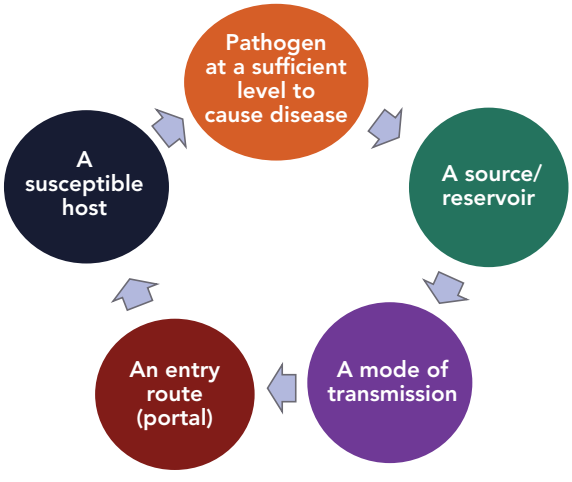

Figure 1. The chain of infection

Contaminated inanimate objects are also known as fomites. The remaining elements in the chain of infection are a mode of transmission for the pathogen, an entry portal through which the pathogen can enter the host, and a host that is susceptible (Fig. 1).

Modes of Transmission

Transmission occurs by several methods in the dental office setting. Direct transmission involves physical contact with oral fluids, blood or other patient materials. Airborne microorganisms may also be present that are then inhaled, and transmission may also occur through contaminated splatter or aerosols. A bacterial aerosol is defined as existing when the particle size is less than 50 µm;[2] such aerosols are most commonly generated during use of an ultrasonic scaler and secondly during use of a high-speed handpiece.[3,4,5,6] Splatter (or droplets) may also be generated by coughing, sneezing or talking.

Aerosols and splatter can contact the mucous membranes of the nasal passages, conjunctiva and oral mucosa of persons present, providing for transmission of microorganisms. Indirect transmission results from contact with a contaminated object, such as environmental surfaces, instruments, devices, or contaminated multi-dose materials containers. Environmental surfaces include housekeeping surfaces (such as walls, sinks and floors) and clinical contact surfaces.

Housekeeping Surfaces

The risk of disease transmission from housekeeping surfaces is low because dental healthcare workers, patients, instruments and other patient treatment items do not usually contact these surfaces. Housekeeping surfaces should

be routinely cleaned with water and detergent, or with a disinfecting solution registered with the Environmental Protection Agency (EPA) and prepared according to the manufacturer's instructions, using a mop or cloth that is cleaned and allowed to dry between uses (or with a single-use mop or cloth). The cleaning solution should be fresh each day to avoid the risk of using a contaminated solution or container. If a housekeeping surface is visibly contaminated or thought to be contaminated with blood or other potentially infectious materials (OPIM), patient materials, or with diluted body fluids, it should be both cleaned and disinfected (Fig. 2). Walls, windows and curtains should be cleaned when they are visibly dirty/dusty.[1]

Personal Protective Equipment (PPE)

During the handling of environmental surfaces as well as waterlines and evacuation lines, the dental healthcare worker should wear heavy-duty utility gloves. These are resistant to puncture and to chemicals used for cleaning and disinfection. Using medical/surgical gloves during operatory cleanup does not protect against puncture if sharps are present, and glove materials, in particular latex, have been shown to be compromised by chemicals.[7,8] Protective eyewear and a mask, or a face shield and a mask, must also be worn, as must protective attire.

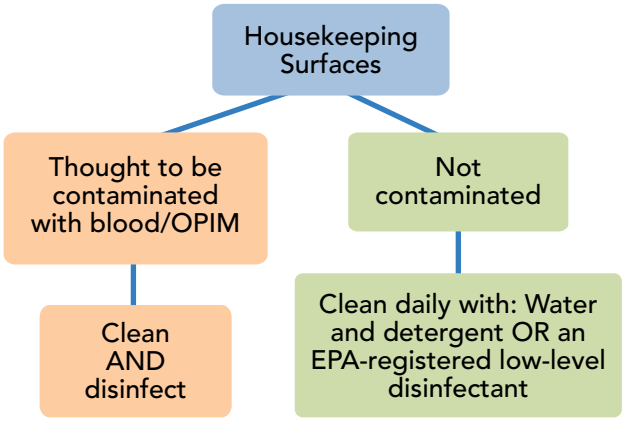

Figure 2. Treatment of housekeeping surfaces

Clinical Contact Surfaces

Clinical contact surfaces include chairs, light handles, countertops, radiographic equipment, dental units and attachments, bracket tables, handles or knobs on drawers, computer equipment, and containers for multi-dose materials (Fig. 3). The risk of disease transmission from contaminated clinical contact surfaces has been documented in several instances. In one dental clinic, the dental chair arm

Figure 3. Clinical contact surfaces (CCS)

Figure 4. Microorganisms from a chair back, cultured on an agar plate

and air-water syringe were contaminated with methicillin-resistant *Staphylococcus aureas* (MRSA), and the chair arm provided indirect transmission of MRSA to patients.[9] The risk of diffusion of MRSA from contaminated surfaces has also been documented.[10] In addition, Hepatitis B transmission from one patient to another patient treated on the same day in a dental office has occurred, where it was theorized that contaminated surfaces may have played a role.[11] In hospital settings, contaminated surfaces have contributed to the transmission of numerous microorganisms, including *Clostridium difficile*, vancomycin-resistant *Enterococci*, MRSA and *Pseudomonas aeruginosa*.[12-17] One assessment of radiographic equipment found MRSA on X-ray cones and switches, and on the surfaces of X-ray solution tanks in a dental clinic.[18] *Viridans Streptococci*, MRSA and other organisms have all been found on dental operatory surfaces.[19,20] Figure 4 shows an agar plate cultured with microorganisms derived from the back of a chair.

Methods of Contamination to and from Clinical Contact Surfaces

Contamination of clinical contact surfaces occurs mainly as a result of:

- Contact with contaminated hands or gloves
- Contact with a contaminated instrument or container
- A bacterial aerosol.

Grenier et al found significant increases in the level of bacteria measured as colony-forming units (CFUs) post-treatment, including as far as 11 meters away from the treatment site, following generation of a bacterial aerosol.[21] A second study found significant increases in multi-chair settings, with up to 500% increases in CFUs.[22]

Microorganisms can be transmitted *from* fomites through contact with hands, gloves, instruments, devices or other clinical care items and subsequently be transferred to patients or dental healthcare personnel. Depending on the microorganism and the conditions, it can remain viable on clinical contact surfaces for up to several months if untreated (Table 1). *The protection and disinfection of clinical contact surfaces is one of the key elements of infection prevention*. Clinical contact surfaces can be treated with barrier protection or surface disinfectants.

TABLE 1. Potential persistence of microorganisms

Microorganism	Potential persistence
Bordetella pertussis	3 – 5 days
Candida albicans	1–120 days
Clostridium difficile	5 months
Escherechia coli	1.5 hours – 16 months
Herpes Simplex virus	4.5 hours - 8 weeks
HIV/HBV	More than 1 week
Mycobacterium tuberculosis	1 day – 4 months
HCV	6 weeks
Rhinovirus	2 hours - 7 days
Staphylococcus aureus (incl. MRSA)	7 days – 7 months

Sources: Kramer EM et al. *BMC Infectious Diseases* 2006;6:130. Paintsil E et al. *Infect Dis* 2014; 209(8):1205–1211.

Barrier Protection

Barrier protection can be used for clinical contact surfaces such as operatory light handles (Fig. 5), headrests, radiographic equipment (such as cones and holders), switches, operatory computer equipment, connectors and hoses, dental

Figure 5. Example of barrier protection

chair, dental unit and bracket table, and curing lights. Using barrier protection saves time, reduces exposure to chemicals and may better protect areas that are more difficult to access for disinfection. *Barrier protection must be removed and replaced between patients*. If any barrier protection becomes torn or damaged during use or during its removal, then the underlying surface must be cleaned and disinfected. *At the end of the day, all clinical contact surfaces must be cleaned and disinfected with an EPA-registered, hospital-grade disinfectant, whether or not barrier protection had been used.*

Cleaning and Disinfecting Clinical Contact Surfaces

Cleaning and disinfecting are required for all exposed clinical contact surfaces (i.e., those that were not covered with barrier protection or where this was compromised). Cleaning is required to remove debris prior to disinfection. Debris can include salts, soils and organic matter (including blood). If not removed, debris compromises disinfection and the surface may remain contaminated due to an inability of the disinfectant to reach and inactivate (kill) microbes. Cleaning and disinfecting can be performed as a one-step or a two-step process. The one-step process combines cleaning and disinfecting and may be used only if there is no heavy soiling of the surface. One-step chemicals must contain both a disinfectant and a detergent.[23] A two-step process can use the same product twice during the process or use different products sequentially, depending on their intended use. The directions on the product labeling must be followed in order to comply with Federal law, including but not limited to the instructions for use, shelf life and disposal.[24]

The EPA is responsible for registering intermediate- and low-level surface disinfectants. *Disinfection of clinical contact surfaces must be performed using an EPA-registered chemical disinfectant acceptable for this purpose.[1] These will have an EPA registration number, which is required on the disinfectant's label*. If there is no EPA registration number, the product should not be used. Combination cleaners/disinfectants must also be EPA-registered.

Selecting Clinical Contact Surface Cleaners and Disinfectants

An intermediate-level, EPA-registered disinfectant (i.e., one with tuberculocidal activity) must be used for clinical contact surfaces with visible blood. The reason for a measure and kill time for tuberculocidal activity is that, with the exception of spores, this is the most resistant microorganism; if this microorganism is killed, then other less-resistant microorganisms have also been killed (Fig. 6). The non-enveloped viruses include poliovirus, Hepatitis A, rhinovirus, Coxsackie virus, and the Norwalk-like virus. Although low-level, EPA-registered disinfectants with an HIV and HBV claim are permitted if no visible blood is present, blood can be present but difficult to see/missed, and therefore use of only an intermediate-level disinfectant removes this as an issue. This also saves the need for the office to have both intermediate- and low-level disinfectants in inventory.

When selecting products for use on clinical contact surfaces, consideration should be given to a number of factors. First, a decision must be made as to whether a one-step or a two-step process may be used based on conditions (if a one-step would be preferred).

Available EPA-registered chemicals for surface disinfec-

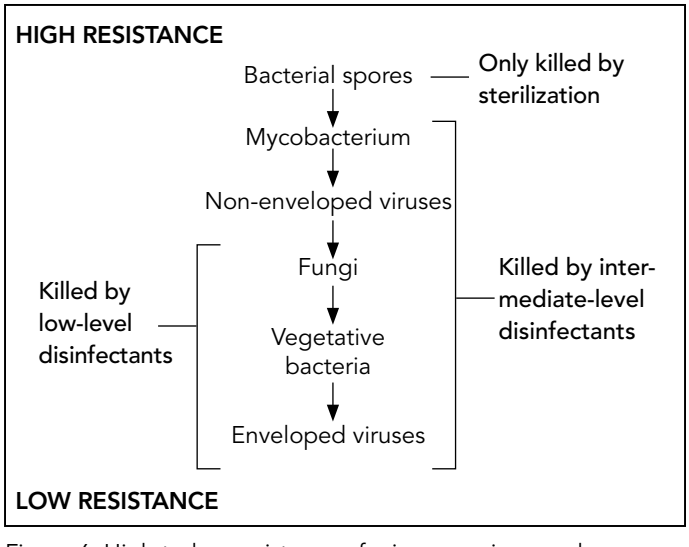

Figure 6. High-to-low resistance of microorganisms and appropriate disinfectants

tion include hydrogen peroxide, complex phenolics, dual quaternary ammonium, and citric acid. Diluted household bleach and alcohol are not EPA-registered and may not be used for clinical contact surface disinfection. Glutaraldehyde may not be used due to the noxious and toxic vapors arising from its use. Note that the FDA regulates high-level disinfectants/sterilants, which require liquid immersion, and these are not suitable or indicated for use on clinical contact surfaces.

Always using an intermediate-level, EPA-registered disinfectant makes it unnecessary to carry two disinfectants, ensures the highest level of disinfection and avoids the need to ascertain whether visible blood is present. *Shorter tuberculocidal kill times are desirable because the disinfectant must remain liquid on the clinical contact surface for that length of time*. Kill times range from 1 minute to 10 minutes, depending on the chemical used and the specific product, and can be found on the product labeling. Requirements and preferable properties for clinical contact surfaces can be found in Table 2.

Surface disinfectants are available as solutions, sprays and wipes. If using solutions, pre-diluted solutions avoid exposure during mixing and the chance of incorrect dilution present with concentrates, but they require more inventory space. If using sprays, an appropriate amount of disinfectant should be sprayed close to the clinical contact surface per the manufacturer's instructions for use. Disinfectant sprays and wipes remove the use of solutions, reducing exposure to chemicals and avoiding the risk of spillage. They also result in less disinfectant being used, reduced exposure and reduced disposal of disinfectant. The one-step process involves wiping and waiting while the chemical disinfects the surface. A two-step process may be either a spray-wipe-spray procedure or a wipe-throw-wipe procedure.

Table 2. Disinfectants

Requirements
Must be EPA-registered
Proven to remain liquid on the surface for the required kill time
Proven safe and effective
Non-toxic and biocompatible
Compatible with clinical contact surfaces
Preferable
Shorter TB kill time (intermediate-level disinfectants)
Shorter HBV/HIV kill time (low-level disinfectants)
Pleasant scent
Easy to use
Dual use product – cleaning and disinfecting

Spray-Wipe-Spray

The surface is sprayed first for cleaning either with a product that contains both a disinfectant and detergent or with a separate detergent product. Then the surface is wiped to remove debris and bioburden. *Next, an EPA-registered disinfectant is sprayed over the surface and allowed to air-dry (Fig. 7). This must remain in contact with the surface and active (i.e., wet - before it dries) for the period of time stated on the labeling for the tuberculocidal kill time.*

Wipe-Throw-Wipe

For this process, a wipe is first used to clean the surface and then disposed of, after which a second wipe is used for disinfecting. As before, if using the same product, it should contain both a detergent for cleaning and an EPA-registered disinfectant appropriate for clinical contact surfaces. *Following use of the second wipe, the surface is left for the required kill time (Fig. 8)*. Wipes use the least volume of disinfectant. Using wipes also reduces the risk of aerosolization and inhalation during use, which helps prevent disinfectant-related health problems. If using impregnated wipes, ascertain that the wipes contain sufficient liquid to cover the surface and remain wet for the required tuberculocidal kill time. The size of the surface areas for which a single wipe is used must also be in accordance with the labeling.

Other Considerations for Reducing Contamination and Transmission

Additional measures that may reduce or remove the risk of contamination of clinical contact surfaces include:

- Flat-surface keyboards and washable keyboards that can be disinfected
- Barrier protection for computers and iPads
- Wireless mouse and devices that remove the need for wiring
- Wireless digital radiography sensors
- Digital radiography
- No-touch soap dispensers
- No-touch paper towel dispensers
- Use of rubber dams where possible
- High-power suction devices
- Vacuum aspirators
- HEPA filters
- UV radiation
- Keeping treatment areas uncluttered, making cleaning and disinfecting easier (Fig. 9)
- Patient rinsing pre-treatment with an antimicrobial rinse.

Strong suction devices, vacuum aspirators, ultraviolet irradiation, HEPA filters and the use of rubber dams reduce the risk from microbe-laden aerosols that may subsequently contaminate clinical contact surfaces.[25-27] Having patients rinse pre-operatively with an antimicrobial rinse such as chlorhexidine gluconate or essential oil mouth rinses has been shown to reduce the microbial load and would therefore reduce the level of microorganisms in bacterial aerosols created during dental procedures. *Significant reductions in the level of CFUs has been shown to occur following pre-rinsing with antimicrobial rinses*.[28-33]

Figure 7. Spray-wipe-spray process

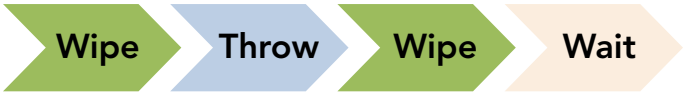

Figure 8. Wipe-throw-wipe process

Dental Unit Waterlines and Evacuation Lines

Dental unit waterlines (DUWLs) are the narrow-lumen tubing used to convey water to handpieces, ultrasonic scalers and air-water syringes during treatment, as well as for rinsing. DUWL contamination occurs as a result of microorganisms in the public water supply and microorganisms introduced into DUWL by backflow (suck-back/retraction) of fluids during patient treatment. DUWL-connected devices are fitted with valves to prevent retraction of fluids; however, these may fail. DUWL-connected devices can transmit microorganisms into a patient's mouth or to other waterlines, and these microorganisms may be aerosolized and then inhaled or settle onto environmental surfaces. Reservoir bottles can also be a source for pathogens, resulting from the improper handling of these bottles.[34]

The Formation and Characteristics of DUWL Biofilm

Biofilm formation on new DUWLs takes just hours. Microorganisms start to adhere to the internal surface of waterline lumens, supply sites for other microorganisms to adhere, and release polysaccharides that further aid adhesion and protect microorganisms during formation of a complex biofilm on the lumen surface.[35,36] The water in these narrow lumens is slow-flowing by nature and frequently stagnant,

Figure 9. Cluttered surface Uncluttered surface

aiding biofilm development.[37] Once formed, biofilm is difficult to dislodge and remove from waterlines. The majority of bacteria in DUWLs are heterotrophic bacteria persisting in the public water supply.[38] However, DUWLs have been contaminated with *Pseudomonas aeruginosa, Legionella* species and *Mycobacteria* (nontuberculous), which are potentially pathogenic for susceptible hosts.[39-41] *Legionella* species and *Mycobacteria* from DUWLs have been aerosolized.[41] However, until recently there was no confirmed case of Legionnaires' disease associated with transmission of *Legionella* from DUWLs.[42] That changed with a recent case in Italy, where an octogenarian died of Legionnaires' disease confirmed to have been the result of *Legionella* in DUWLs and likely transmitted by aerosolized water from the high-speed handpiece turbine.[43] Earlier reports existed but were not definitive, including the death of a dentist whose dental office had extremely high levels of *Legionella* in DUWLs.[44] Hepatitis C viral RNA has also been reported in DUWLs,[45] as has *Staphylococcus aureus* acquired from patients carrying this organism.[43,46] Exposure to aerobic bacteria endotoxins from contaminated DUWLs was also found in one study to be associated with occupational-acquired asthma in dentists.[47]

Although the risk of disease is low based on the number of confirmed and suspected cases of infection arising from DUWLs, guidelines must be followed to break the chain of infection and prevent transmission.

Guidelines and Treatment of Dental Unit Waterlines

The CDC guidelines state that DUWLs should contain bacterial levels that are no more than 500 CFU/ml, the acceptable level for aerobic heterotrophic (noncoliform) bacteria in drinking water. *During surgical procedures only sterile water may be used, and during a boil water advisory the public water supply should not be used during any patient care*. If reservoir bottles are used, wear gloves and avoid exposed skin when handling these to prevent contamination of the water with microorganisms. The bottles should be cleaned and disinfected, or autoclaved (if autoclavable), regularly. With closed water systems, avoid touching the tubing with gloves or hands to prevent contamination. *Handpieces should be flushed for 20–30 seconds after each patient to help reduce the presence of any patient fluids and to reduce the level of microorganisms in DUWL-derived water*.[1] Options for maintaining and improving the quality of DUWL water include point-of-use filters, microfiltration for each outlet, treatments using silver ions or iodine, daily draining and air purging, independent water systems, and chemical treatments.[48] The maintenance instructions of the dental unit manufacturer must be followed, as must the recommendations on monitoring water quality. Testing for water quality can be performed in the office or in an external laboratory. Based on test results, if CFU/ml levels exceed the recommended maximum, a shock treatment is used to bring the CFU/ml back to an acceptable level, after which a treatment and maintenance schedule is resumed.

Agents used for the treatment of DUWLs include hydrogen peroxide, alkaline peroxide, chlorhexidine gluconate, silver, iodine, peracetic acid, diphenol hydroxybenzene, quarternary ammonium and chlorine dioxide (Table 3).[49-52] *The only option that can inactivate and remove existing biofilm is the use of chemicals on a regular basis*. Selection of chemical treatments should consider a number of factors, including efficacy, safety, cost, compatibility with dental units and materials, ease-of-use, lack of odor and taste, toxicity, and disposal. In addition, the manufacturer's schedule and instructions for use must be followed. Recently, new technology has been introducd that utilizes an autoclavable cassette system that involves sterilization of the water, water

Table 3. DUWL treatment options and management

Chemicals, on a regular schedule per the manufacturer's instructions
Handpiece flushing 20–30 seconds after each patient*
Daily draining and air purging*
Point-of-use filters
Water purifiers using silver ions or iodine
Microfiltration for each outlet
Independent water systems

** In addition to other methods, not instead of them*

container, and waterline tubing for the handpiece, air and water syringe.

Evacuation Lines

Evacuation lines include the saliva ejector (low-speed suction), high-speed suction line and cuspidor. Backflow from saliva ejectors has been demonstrated by investigators using red dye in these that then became deposited in patients' mouths when patients closed their lips around the saliva ejectors.[53] Saliva ejectors typically do not have anti-retraction valves and provide low-volume suction. *Patients should be instructed not to close their lips over saliva ejectors to avoid backflow and dislodging of biofilm*. Rinsing suction lines between patients helps remove microorganisms and debris that accumulated during individual patient care.

At the end of each day, all evacuation lines must be flushed with a cleaner to help reduce debris and the number of microorganisms. Failure to clean evacuation lines daily leads to biofilm growth, a heavy bioburden and a greater risk of transmission. Evacuation lines and traps must be handled only when wearing utility gloves (and not single-use medical or surgical gloves), as well as other PPE. Chemicals used to clean evacuation lines remove deposits and debris, deodorize, and clean. Evacuation line chemicals also help prevent the buildup of deposits, including calcium. Studies have found that high-level chlorine and bleach cleaners for DUWLs/evacuation lines have the potential for releasing mercury from amalgam.[54-56] Acidic, basic and neutral cleaners are all available for evacuation lines. It is important to note that acidic cleaners can interfere with amalgam separators working, and highly alkaline (basic/high pH) cleaners can result in early wear of the separator.

Figure 10. Evacuation line system

As stated above, evacuation line cleaning is required daily in each operatory. To facilitate this, systems are available that incorporate a dispenser and simplify evacuation line disinfection in the multi-chair dental office. Figure 10 is an example of this type of dispenser bucket with measuring lines and attachments for both high- and low-speed suction lines. The bucket can be filled with sufficient cleaner for up to three operatories, and the measuring lines indicate the amount required for each operatory. The action in the bucket mixes air and solution to minimize pressure on the pump. If operatories use this type of system, the vacuum line should remain on after cleaning the evacuation line in each operatory until all the operatories have been treated, starting with the one farthest from the pump. This helps prevent the cleaner or debris from remaining lodged in the evacuation line.

Regardless of which cleaner or system is being used, the manufacturer's instructions for use must be followed. The recommendations/instructions of the manufacturers of the dental unit and the amalgam separator should be followed.

Evacuation Lines and Amalgam Separators

Best practices for amalgam handling and disposal, developed by the American Dental Association, include the use, inspection and cleaning of chairside traps; vacuum collection; the use of amalgam separators (ISO 1114322–compliant); and appropriate disposal of amalgam.[56] Amalgam separators are used as part of the suction system to remove amalgam and prevent it from entering the wastewater system and resulting in the release of mercury into the environment. These separators trap amalgam particles and other solids that enter the suction lines during use. The canisters contained in amalgam separators must be disposed of and replaced when

full, and these full canisters must be recycled. In accordance with best practices, full canisters and their contents, as well as the content of chairside traps, must not be placed in the general trash or in hazardous waste bags or be rinsed or flushed down drains. The vacuum pump should also be checked for any residual amalgam, which should be recycled.

In addition, using an evacuation cleaner that does not result in the release of mercury from amalgam will aid in the safe disposal of amalgam and help increase the efficiency of amalgam separators. As such, non-chlorine and non-bleach evacuation line cleaners are appropriate for use. The evacuation line cleaner selected should meet the specifications of the amalgam separator manufacturer, be easy to use, and have a pleasant odor and low toxicity.

Summary

The treatment of environmental surfaces, dental unit waterlines and evacuation lines is essential for infection prevention. The guidelines of the CDC must be followed and consideration given to the process that will be followed and the cleaners/disinfectants that will be used for infection prevention at the start of each day, between patients and at the end of each day.

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CEQuiz

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1. **The chain of infection requires that a reservoir or source be present for a _____ at a level sufficient to result in infection.**
   a. pathogen
   b. parasite
   c. chemical
   d. none of the above

2. **Contaminated inanimate objects are also known as _____.**
   a. fulmites
   b. microorganisms
   c. fomites
   d. a and c

3. **Direct contact transmission involves physical contact with _____.**
   a. oral fluids
   b. blood
   c. other patient materials
   d. all of the above

4. **A bacterial aerosol is defined as existing when the particle size is _____.**
   a. more than 25 µm
   b. more than 50 µm
   c. less than 25 µm
   d. less than 50 µm

5. **During the handling of _____, heavy-duty utility gloves and other appropriate PPE should be worn.**
   a. evacuation lines
   b. waterlines
   c. environmental surfaces
   d. all of the above

6. **In one dental clinic, the _____ and _____ were contaminated with methicillin-resistant *Staphylococcus aureas*.**
   a. dental arm chair; air water syringe
   b. bur; latex glove
   c. latex glove; dental arm chair
   d. none of the above

7. **_____ transmission from one patient to another patient treated on the same day in a dental office has occurred.**
   a. Hepatitis B
   b. Cancer
   c. Diabetes
   d. Heart disease

8. **The water in DUWLs is _____ in nature and _____ stagnant, aiding biofilm development.**
   a. slow-flowing; frequently
   b. free-flowing; never
   c. slow-flowing; never
   d. stagnant; always

9. **The EPA is responsible for registering _____.**
   a. instruments
   b. intermediate- and low-level surface disinfectants
   c. veneers
   d. all of the above

10. **A(n) _____ level, EPA-registered disinfectant (i.e., one with tuberculocidal activity) must be used for clinical contact surfaces with visible blood.**
    a. low-level
    b. intermediate-level
    c. high-level
    d. all of the above

11. **Microorganisms can be transmitted from fomites through contact with _____ and subsequently be transferred to patients or dental healthcare personnel.**
    a. hands
    b. gloves
    c. instruments
    d. all of the above

12. **At the end of the day, all clinical contact surfaces must be cleaned and disinfected with _____ whether or not barrier protection had been used.**
    a. isopropyl alcohol
    b. water
    c. an EPA-registered, hospital-grade disinfectant
    d. all of the above

13. **Handpieces should be flushed for _____ seconds after each patient to help reduce the presence of any patient fluids and to reduce the level of microorganisms in DUWL-derived water.**
    a. 1-10 seconds
    b. 10-20 seconds
    c. 20-30 seconds
    d. 30-40 seconds

14. **Housekeeping surfaces should be routinely cleaned with _____ or _____, using a mop or cloth.**
    a. water and detergent; a disinfecting solution registered with the EPA
    b. high-level disinfectant; alcohol
    c. alcohol; solvent
    d. none of the above

15. **Disinfectants must have an EPA registration number, which is required on the disinfectant's label. If there is no_____, the product should not be used.**
    a. EPA registration number
    b. list of possible side effects
    c. isopropyl alcohol
    d. all the above

CE QUIZ

16. Contamination of clinical contact surfaces occurs mainly as a result of _____.
a. contact with contaminated hands or gloves
b. contact with a contaminated instrument or container
c. a bacterial aerosol
d. all of the above

17. _____ and _____ are required for all exposed clinical contact surfaces.
a. Cleaning; disinfecting
b. Rinsing; scrubbing
c. Scrubbing; cleaning
d. None of the above

18. Available EPA-registered chemicals for surface disinfection include _____.
a. hydrogen peroxide
b. complex phenolics
c. dual quaternary ammonium
d. all of the above

19. Glutaraldehyde is not used as a disinfectant because _____.
a. noxious and toxic vapors arise from its use
b. it is not strong enough to be a disinfectant
c. it stains the skin
d. none of the above

20. _____ use the least volume of disinfectant.
a. Sprays
b. Wipes
c. Solutions
d. all of the above

21. _____ cleaners can result in early wear of the amalgam separator.
a. Low-alkaline
b. Medium-alkaline
c. High-alkaline
d. All of the above

22. Biofilm formation on new DUWLs takes _____.
a. minutes
b. hours
c. days
d. weeks

23. DUWLs are the _____ used to convey water to handpieces, ultrasonic scalers and air-water syringes during treatment, as well as for rinsing.
a. copper piping
b. wide-lumen tubing
c. narrow-lumen tubing
d. none of the above

24. Exposure to aerobic bacterial endotoxins from contaminated DUWs was found in one study to be associated with _____ in dentists.
a. caries
b. MRSA
c. occupational-acquired asthma
d. none of the above

25. A(n) _____ is an evacuation tool.
a. saliva ejector
b. high-speed suction line
c. cuspidor
d. all of the above

26. Failure to clean evacuation lines daily leads to _____
a. biofilm growth
b. a heavy bioburden
c. a greater risk of transmission
d. all of the above

27. At the end of each day, all evacuation lines must be flushed with a cleaner that will remain in the vacuum system _____ to help reduce debris and the number of microorganisms.
a. two hours
b. four hours
c. six hours
d. overnight

28. Evacuation line chemicals help prevent the buildup of deposits, including _____.
a. calcium
b. amalgam
c. chlorine
d. none of the above

29. _____ and _____ evacuation line cleaners are appropriate for use with amalgam separators.
a. Chlorine; bleach
b. Chlorine; non-bleach
c. Bleach; non-chlorine
d. Non-chlorine; non-bleach

30. The guidelines of the _____ must be followed and consideration given to the process that will be followed and the cleaners/disinfectants that will be used for infection prevention at the start of each day, between patients and at the end of each day.
a. CDC
b. EPA
c. FDA
d. none of the above

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EDUCATIONAL OBJECTIVES

1. List and describe the manner in which environmental surfaces may become contaminated and contribute to the chain of infection;
2. Review the methods by which housekeeping and clinical contact surfaces can be cleaned and disinfected, as well as associated considerations;
3. List and describe the role of dental waterlines in cross-contamination and the transmission of microorganisms, and procedures that must be followed; and,
4. Delineate the role of evacuation cleaners, their use and considerations in their selection.

COURSE EVALUATION

Please evaluate this course using a scale of 3 to 1, where 3 is excellent and 1 is poor.

1. Clarity of objectives ..... ③ ② ①
2. Usefulness of content ..... ③ ② ①
3. Benefit to your clinical practice ..... ③ ② ①
4. Usefulness of the references ..... ③ ② ①
5. Quality of written presentation ..... ③ ② ①
6. Quality of illustrations ..... ③ ② ①
7. Clarity of quiz questions ..... ③ ② ①
8. Relevance of quiz questions ..... ③ ② ①
9. Rate your overall satisfaction with this course ..... ③ ② ①
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2.	Ⓐ Ⓑ Ⓒ Ⓓ	17.	Ⓐ Ⓑ Ⓒ Ⓓ
3.	Ⓐ Ⓑ Ⓒ Ⓓ	18.	Ⓐ Ⓑ Ⓒ Ⓓ
4.	Ⓐ Ⓑ Ⓒ Ⓓ	19.	Ⓐ Ⓑ Ⓒ Ⓓ
5.	Ⓐ Ⓑ Ⓒ Ⓓ	20.	Ⓐ Ⓑ Ⓒ Ⓓ
6.	Ⓐ Ⓑ Ⓒ Ⓓ	21.	Ⓐ Ⓑ Ⓒ Ⓓ
7.	Ⓐ Ⓑ Ⓒ Ⓓ	22.	Ⓐ Ⓑ Ⓒ Ⓓ
8.	Ⓐ Ⓑ Ⓒ Ⓓ	23.	Ⓐ Ⓑ Ⓒ Ⓓ
9.	Ⓐ Ⓑ Ⓒ Ⓓ	24.	Ⓐ Ⓑ Ⓒ Ⓓ
10.	Ⓐ Ⓑ Ⓒ Ⓓ	25.	Ⓐ Ⓑ Ⓒ Ⓓ
11.	Ⓐ Ⓑ Ⓒ Ⓓ	26.	Ⓐ Ⓑ Ⓒ Ⓓ
12.	Ⓐ Ⓑ Ⓒ Ⓓ	27.	Ⓐ Ⓑ Ⓒ Ⓓ
13.	Ⓐ Ⓑ Ⓒ Ⓓ	28.	Ⓐ Ⓑ Ⓒ Ⓓ
14.	Ⓐ Ⓑ Ⓒ Ⓓ	29.	Ⓐ Ⓑ Ⓒ Ⓓ
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