Pathways to Infection Prevention

By Fiona M. Collins, BDS, MBA, MA
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ABSTRACT

To prevent the transmission of microorganisms and disease, a robust infection control program is required. The guidelines from the Centers for Disease Control provide recommendations for infection control in the dental healthcare settings, and in order to break the chain of infection and prevent disease transmission attention to every detail of infection control procedures is required. Steps include those required at the beginning and end of the day, and repeated procedures that are performed for each and every patient. CDC guidelines, OSHA and EPA regulations must be followed and appropriate FDA-cleared supplies used for infection control.

EDUCATIONAL OBJECTIVES

The overall goal of this course is to provide the reader with information on infection prevention. On completion of this course, participants will be able to:

1. Describe the chain of infection and modes of transmission
2. List the elements involved in the daily infection prevention cycle
3. Review the importance of hand hygiene, appropriate procedures, and factors that influence compliance with hand hygiene
4. List and describe the steps involved in the treatment of clinical contact surfaces
5. Delineate each step in instrument processing
6. Describe the activities necessary at the beginning and end of each day.

Introduction

Infection prevention is essential to provide safe care and to protect patients, dental healthcare workers, and the community at large. The emergence or reemergence of infectious diseases such as SARS, tuberculosis, HIV/AIDS, and avian flu variants again highlight the importance of infection prevention in all settings. At the same time, microbial antibiotic resistance is increasing and a scenario where antibiotics are no longer effective against infectious diseases can be foreseen. Specific bacteria are already resistant and increasingly resistant to antibiotic therapies—for example, methicillin-resistant Staphylococcus aureus (MRSA) and vancomycin-resistant enterococci (VRE).1,2 Infection prevention protocols must be adhered to for all patients on the basis that any given patient may be infected with microorganisms that cause transmissible diseases. The Centers for Disease Control and Prevention’s Guidelines for Infection Control in Dental Health-Care Settings—2003 provides guidance on infection prevention and the necessary procedures.3

ABOUT THE AUTHOR

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Dr. Collins has authored and presented on caries prevention and treatment modalities, xerostomia, dentifrices, biofilm, artificial sweeteners, infection control, tobacco cessation and compliance. She has given presentations to dental professionals and students in the US, Canada, Mexico, Europe, the Pacific Rim and the Middle East, and has experience in general dentistry, academia, industry and as a consultant, speaker and author. Dr. Collins is the Continuing Education Editor for Dental Learning. Dr. Collins has been a member of the British Dental Association, the Dutch Dental Association, the International Association for Dental Research and the Academy of General Dentistry Foundation Strategy Board. She is currently a member of the American Dental Association, the Organization for Asepsis, Safety and Prevention (OSAP), and a Fellow of the Pierre Fauchard Academy. Dr. Collins earned her dental degree from Glasgow University, Scotland and holds an MBA and an MA from Boston University, USA.
The Chain of Infection

The chain of infection comprises five elements that are required for disease transmission (Figure 1). Examples of sources/reservoirs include the oral cavity, bloodstream, contaminated instruments and surfaces, and evacuation lines. Entry portals include oral and nasal mucosa, ocular tissue, an open wound or punctured skin.

Modes of Transmission

There are several modes of transmission in the dental office setting:

- Direct contact with blood, oral fluids, or other patient materials
- Indirect contact with a contaminated instrument or inanimate object
- Inhalation of airborne or aerosolized microorganisms
- Contact of oral, nasal, or ocular mucous membranes with contaminated aerosol, splatter, or droplets.

To prevent cross-contamination and disease transmission, the chain of infection must be broken and a rigorous infection prevention protocol followed.

Breaking the Chain of Infection

Infection control protocols that break the chain of infection:

- Reduce the presence and level of pathogens
- Remove/address sources of pathogens
- Prevent transmission
- Protect against potential entry portals
- Reduce host susceptibility.

Host susceptibility depends on a person’s health as well as his/her vaccination status. Healthcare worker immunization recommendations were published in 1997, and since then recommendations have been updated. All healthcare workers should receive the Hepatitis B vaccine. After receiving hepatitis B vaccinations, the recipient should be tested for seroconversion 1-2 months following the third (and final) dose. All dental healthcare workers must be offered hepatitis B vaccinations by the employer at no charge and educated on bloodborne pathogens as well as the protective nature of the vaccine. Records must be kept of the vaccination status of everyone working in the dental office. If an employee refuses vaccination, he/she must sign the Hepatitis B declination form. For dental healthcare workers, inoculation against influenza; measles, mumps, rubella (German measles) (MMR vaccine); varicella (chickenpox and herpes zoster); tetanus, diphtheria and pertussis (whooping cough) (Tdap vaccine); and Hepatitis C are also recommended.

Infection Prevention Compliance

Although a complete lack of regard for appropriate infection control recommendations and guidelines is fortunately rare, there are several other reasons why compliance may be lacking. Surveys confirm inadequate adherence to recommendations and guidelines related to hand hygiene, personal protective equipment (PPE), exposure to bloodborne pathogens, surface disinfection, the use of safety devices, instrument processing, sterility assurance, and maintenance of dental unit waterline quality. In a large US survey conducted in 2008 with more than 3,000 respondents, only 26% of practices had implemented three of four recommendations being assessed for compliance and 34% of practices had implemented one or none. Another survey, this time with dental students (n=220), found that 47% had inadequate knowledge about the transmission of bloodborne pathogens and 37% had inadequate knowledge about post-exposure management in the event of a percutaneous injury. Education on infection prevention, selection of user-friendly products and a systematic, streamlined approach all aid compliance. Staff must be educated on the risks of disease transmission, prevention, and management of exposure to bloodborne pathogens.

Infection Prevention

The infection prevention cycle involves procedures...
performed at the start and end of the day and procedures that are repeated before, during and after providing clinical care to individual patients throughout the day. This set of procedures must meet the requirements of current standards, guidelines, and recommendations. Using a systematic approach in a standardized, reliable, and repeatable manner helps to ensure effective and safe infection prevention and aids compliance with all steps involved. Using a system that includes educational sessions, cross-training, and the use of tracking and documentation aids the smooth performance of these steps and can provide assurance that infection control procedures are being performed as required.

Beginning of the day – preparation of operatory

Prior to the first patient being seen, the operatory must be prepared and barrier protection placed on applicable clinical contact surfaces to protect these from contamination.

Preparation prior to patient care

All operatory dental healthcare workers must perform hand hygiene and don PPE prior to patient care, including gloves, masks, gowns and protective eyewear.

Hand Hygiene

The CDC issued recommendations for hand hygiene in healthcare settings in 2002. The World Health Organization emphasizes hand hygiene as a public health measure in the community. Skin consists of a superficial layer where transient microorganisms that are most frequently associated with disease transmission exist and deeper layers where resident flora is present. Hand hygiene is the single most important factor in preventing disease transmission and is performed with the objective of removing transient flora that can be transmitted from one person to another or to an inanimate object. Keeping fingernails (or artificial nails) short and smooth makes hand hygiene under nails easier and reduces the risk of glove puncture. If nail polish is chipped and worn, it should be removed, as chipped and worn nail polish can harbor microorganisms. Hand hygiene should be conducted prior to donning and after removing gloves, when changing out gloves during patient care, and following ungloved skin contact with patients and/or potentially contaminated inanimate objects (fomites). Removing hand and wrist jewelry before performing hand hygiene enables more thorough hand hygiene and not wearing jewelry helps prevent damage to gloves.
Hand hygiene for routine procedures

Hand hygiene can be performed with antimicrobial/plain (i.e., nonantimicrobial) soap and water OR an alcohol-based handrub, if no debris is present. If debris is present, soap and water must be used to remove the debris, as handrubs will not remove this. Hand washing should last for at least 15 seconds while rubbing your hands with soap and water. Active ingredients found in antimicrobial soaps include chloroxylenol, 2% and 4% chlorhexidine, iodophors, 0.3% triclosan, phenols and quaternary ammonium.

Hand hygiene for surgical procedures

For surgical procedures, hand antisepsis is required because of the more invasive nature and risk of transmission with these procedures. An antimicrobial soap with persistent activity is required if only performing hand washing – this should be performed for 2-6 minutes (product-dependent). Alternatively, plain soap and water may be used if followed by use of an alcohol-based rub with persistent activity.

Other factors require consideration when selecting hand hygiene products, related to usage and compliance can be found in Table 1.

Personal Protective Equipment (PPE) for Patient Care

Operatory personnel must wear single-use medical or sterile surgical gloves (as indicated) for each and every patient, as well as protective eyewear, face masks, and clinical attire. These all act as a barrier, protecting against contact with pathogens and potential disease transmission.

<table>
<thead>
<tr>
<th>Ease of use and reducing contamination</th>
<th>Skin care and improving compliance with hand hygiene</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid- or foam-dispensed soaps in closed containers/ dispensers reduce the risk of contamination.</td>
<td>Foam requires less chemical/soap, reducing the potential for skin irritation.</td>
</tr>
<tr>
<td>Closed containers/dispensers should not be topped off, to avoid contamination of soap.</td>
<td>Nondrying alcohol-based handrubs result in less skin irritation than do soaps.</td>
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<tr>
<td>Dispensers provide an accurate dose of soap for use.</td>
<td>Using soap containing an emollient replenishes moisture and soothes skin.</td>
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<tr>
<td>No-touch soap/sanitizer dispensers reduce contamination.</td>
<td>Avoid hand hygiene products with ingredients that a user may be allergic to.</td>
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<tr>
<td>Only disposable, single-use paper towels should be used to dry hands.</td>
<td>Select products that are user-friendly and effective and feel and smell pleasant.</td>
</tr>
<tr>
<td>No-touch paper towel dispensers reduce the risk of contamination.</td>
<td>Stand-alone hand lotions with emollients reduce dryness and can improve skin health.</td>
</tr>
<tr>
<td>Products used must be compatible with gloves.</td>
<td>Consider use of alcohol-based towelettes/sanitizers if hand washing is not required.</td>
</tr>
<tr>
<td>Some emollients and chemicals compromise glove material; if in doubt, check with the manufacturer.</td>
<td>Avoid the use of oil- and petroleum-containing products, as these degrade latex gloves.</td>
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</table>
Gloves

Single-use medical/sterile surgical gloves protect patients and operatory staff during all patient care. These must be disposed of after use on a single patient. If punctured or torn during patient care, they must be discarded, hand hygiene performed, and fresh gloves donned. It is essential that hand hygiene is performed before donning and after removing gloves. Reuse and washing of gloves for patient care is not permitted. Avoiding wearing sharp jewelry, keeping nails short and smooth, and avoiding oil- and petroleum-containing lotions/creams helps to preserve glove integrity. Sterile surgical gloves must be used for surgical procedures, while nonsterile medical gloves can be used for all nonsurgical procedures on patients.

Additional considerations in glove selection/use

Gloves are available in several materials including latex, natural rubber, vinyl, nitrile, and neoprene. Contact allergies occur in individuals sensitive to latex as well as natural rubber/chemicals in synthetic rubber gloves. In the case of latex, anaphylactic shock can occur. If staff and/or patients have allergies to these materials, their use must be avoided. Alternatives include nitrile, vinyl, and neoprene gloves. Nitrile gloves have been found to have a lower risk of perforation compared to vinyl gloves, as well as a lower risk of blood transmission compared to latex following puncturing with sharps. While not standard practice, double-gloving has been recommended for surgical procedures and procedures with a high risk of glove perforation in dentistry and medicine, with inner gloves exhibiting fewer perforations.

Factors influencing compliance and glove integrity, as well as potential contamination, require consideration and can be found in Table 2.

Medical and surgical gloves are for patient care. They are not indicated for use during operatory cleanup, instrument processing, or treatment of waterlines and evacuation lines. These activities require the use of heavy-duty utility gloves that are puncture- and chemical-resistant.

Masks

Face masks are required to protect the user from inhalation of airborne and aerosolized microorganisms, as well as from droplets and spatter. These must be well-fitting against the face and nose and under the chin, covering the nose and mouth. The mask must be comfortable while offering good breathability, a suitable level of filtration, fluid resistance and flame resistance. The mask that feels good and is comfortable is more likely to be a mask that is used, thereby increasing compliance. For sensitive skin, masks are available that are dye-free and hypoallergenic. During patient care, if a mask becomes damp, it is no longer an effective barrier and must be swapped out for a fresh mask. Note that a new mask must be used for each patient, and masks must be disposed of properly in the trash. In addition, wearing a mask below the nose or chin results in exposure to microorganisms which can then also access the nasal and oral portals of entry. The higher the filtration rating for a mask, the greater the level of protection it offers. Filtration standards have been promulgated by the American Society for Testing Materials (ASTM). Transmission-based precautions recommend the use of NIOSH-certified particulate-filter respirators during an influenza epidemic.

Protective Eyewear

Protective eyewear shields the eyes from debris as well as from the transmission of microorganisms via ocular mucosa. Either protective plastic eyewear that fits snugly over the eyes (and over prescription glasses if these are worn) with protective sides or a face shield may be used. Face shields

<table>
<thead>
<tr>
<th>TABLE 2. Factors influencing compliance, glove integrity and contamination</th>
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<tbody>
<tr>
<td>Right- and left-handed designs increase comfort, compared to ambidextrous gloves.</td>
</tr>
<tr>
<td>Right- and left-handed gloves help reduce the risk of hand and wrist strain.</td>
</tr>
<tr>
<td>Ensure that gloves are available that are suitable for all staff (i.e., correct size and to which an individual is not allergic).</td>
</tr>
<tr>
<td>Chemical exposure compatibility and resistance of the glove material to chemical degradation – latex gloves in particular offer low resistance to a number of chemicals</td>
</tr>
<tr>
<td>Keep gloves in a closed container to reduce the risk of contamination prior to use.</td>
</tr>
<tr>
<td>Purchase gloves from a reliable manufacturer – quality and reliability of gloves varies.</td>
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</tbody>
</table>
provide greater protection, since they cover the face and protect masks from spatter and droplets too. They are not a substitute for masks.

**Barrier Protection for Clinical Contact Surfaces**

Barrier protection can be used for clinical contact surfaces such as operatory light handles, headrests and chairs, radiographic equipment (such as cones and holders), operatory computer equipment and iPads, connectors and hoses, the dental unit and bracket table, and curing lights. The use of barrier protection may better protect areas that are more difficult to access for disinfection, saves time, and reduces the need for cleaning and disinfecting with chemicals. Barrier protection may be placed only on clean, uncontaminated surfaces and must be replaced after treating a single patient.

**Instrument Setups, Supplies, and Accessories**

Having sterile instrument setups in closed, perforated cassettes ready for patient use saves time and provides for greater safety than using loose instruments does. Assembling all required single-use and single-dose items, accessories, and supplies on a disposable tray prior to seeing the patient helps organizationally and reduces the risk of contamination.

**During patient treatment**

During patient care, patients should wear protective eyeglasses and a bib. Prior to treatment, having patients pre-rinse with an antimicrobial rinse (such as chlorhexidine gluconate) helps to reduce the bacterial load and therefore may reduce the microbial load contained in aerosol generated during treatment (typically by an ultrasonic scaler or hand-piece) as well as in spatter or after coughing/sneezing. The risk of microbial contamination through aerosolization is real – significant levels of colony-forming units have been found up to 11 meters from treatment chairs.

The Centers for Disease Control and Prevention recommends the use of single-use, disposable patient care items when possible to reduce the risk of cross-contamination and disease transmission. These also remove the need to clean and sterilize instruments, saving time and reducing the risk of operator error. Available single-use items include bibs, traps, saliva ejectors, air-water syringe tips, high-speed suction tips, prophylaxis angles, burs, endodontic files, and bib clips. In fact, recent studies have shown that, even after appropriate precleaning and sterilization, sterilization of complex-surface instruments such as dental burs and endodontic files is not always successful, with failure rates ranging from 15% (bur set) to 58% (endodontic files).

Reusable bib chains are also a source of potential contamination, with recent studies finding not only bacterial contamination on bib chains after use on a single patient and increasing levels of contamination with repeated patient care episodes (and no disinfection), but also residual contamination of bib chains after cleaning and wipe-disinfection. Using disposable bib clips removes this potential source of transmission from the equation and saves time spent on cleaning and disinfecting. With respect to metal air-water syringe tips, as with bib clips it is very difficult to
clean these and microorganisms have been found in the lumens of metal air-water syringe tips post-sterilization. Using disposable air-water syringe tips removes the associated risk of cross-contamination and disease transmission. Using an aseptic technique, strong aspiration and suction, rubber dams where possible, and HEPA filters also helps to reduce bacterial aerosols and splatter. Care is required when using sharps, with a recent survey of dental students reporting that bloodborne pathogen exposure had occurred in 19.1% of students, with just over 87% of these occurring due to percutaneous injuries. When giving injections, the needle should be recapped immediately, using a safety recapping device or the one-handed scoop technique.

After patient treatment

Following care of an individual patient, a series of sequential procedures is required. These include the disposal of sharps and other single-use patient care items, instrument processing, appropriate treatment of materials destined for the dental laboratory, and care of the operatory in preparation for the next patient.

Disposing of sharps

Sharps disposal chairside, prior to transporting instruments in closed cassettes/trays to the processing area, reduces the risk of percutaneous injuries. The sharps container must be color-coded and puncture-resistant and have a rigid base and walls. Capped syringe needles, disposable scalpels, blades, suture needles, and broken glass carpules should all be placed in the sharps container. Other (nonsharps) single-use disposable items should not be placed in the sharps container. Do not transfer the contents of a smaller sharps container into a larger sharps container (or anything else) and then reuse the smaller container, because of the risk of percutaneous injury while transferring the contents. Sharps containers should be securely closed, sealed, and disposed of in accordance with Occupational Safety and Health Administration (OSHA), state, local, and municipal regulations. OSHA is charged with protecting the health and safety of all workers in the United States. OSHA administers the Bloodborne Pathogens Rule to reduce occupational exposure to bloodborne pathogens, such as hepatitis B, hepatitis C, and HIV. OSHA, state, and municipal regulations define how contaminated instruments and waste should be handled as well as the disposal of such waste.

Disposing of single-use, disposable patient care items (nonsharps) and waste

These may be disposed of chairside or in the instrument processing area. Items such as disposable saliva ejectors, bib chains and bibs, air/water syringes, and single-unit dose materials (except amalgam-related) may be discarded in the general trash provided they do not fall under the categories of regulated and hazardous waste. Barrier wrapping and radiographic single-use disposable tabs, positioners, and holders, as well as contaminated disposable trays, are considered nonhazardous and can be discarded as waste. Lead foil from traditional film packets must be segregated and stored for collection or delivery to an authorized vendor. Regulated medical waste
must be discarded separately. Examples of nonsharps medical waste include blood-soaked gauze, cotton rolls, excised tissue, and extracted teeth that do not contain amalgam restorations. These must be “red bagged” in a leak-proof medical waste container that is labeled/color-coded appropriately, handled and disposed of in accordance with OSHA, state, local, and municipal regulations. Do not discharge liquid waste into the wastewater sewer system unless certain that doing so meets all regulations for your area. Staff should be up-to-date on training and the appropriate handling of all waste.

All dental amalgam must be collected for appropriate retorting, recycling, or disposal due to the risk of mercury release from amalgam. All amalgam must be treated in this manner – this includes old amalgam filling material, contact amalgam in traps, filters and the cuspidor, noncontact amalgam that was excess to requirements, used amalgam capsules, and extracted teeth containing amalgam restorations. In addition, full canisters from amalgam separators must also be segregated. The amalgam sources described above must be “gray bagged” in appropriate containers, labeled, and sent to an authorized vendor. Under no circumstances should amalgam be flushed down sinks or toilets, thrown in the general trash, or placed in medical waste or hazardous waste receptacles. To do so contaminates wastewater systems, landfills, and sludge from water treatment plants that ends up in the ground (and then waterways), and if incinerated, amalgam releases mercury into the atmosphere that then also reaches waterways and, eventually, the food chain.

**Transporting Instruments and Devices to the Instrument Processing Area**

Operator safety is paramount during operatory cleanup, the transportation of used instruments, and further instrument processing:

- Heavy-duty utility gloves, a face mask, and protective eyewear are required during operatory cleanup, the transportation of instruments, and subsequent instrument processing
- Medical and surgical gloves are not indicated
- First remove and discard any medical or surgical gloves if these were being worn, perform hand hygiene, and don heavy-duty utility gloves to reduce the risk of sharps injuries and contact with contaminated instruments, spatter, and chemicals.

Instruments should be covered while transporting them to the instrument processing area. Using closed, perforated instrument cassettes contributes to safety (as well as efficiency during patient care). Contaminated instruments transported in closed cassettes to the instrument processing area pose less risk for sharps injuries than do loose instruments on a tray. In addition, closed perforated cassettes can be placed in presoaks and ultrasonic cleaners or washers/disinfectors prior to packaging and sterilization, further reducing the risk of injury and disease transmission. (Note that nonperforated closed cassettes cannot be used for autoclaving or chemclaving of instruments, as steam/
chemicals cannot penetrate them, but may be used for dry heat sterilization. Instruments in closed nonperforated cassettes must also be handled for cleaning prior to dry heat sterilization.)

**Operatory care**

After disposal of single-use items and transportation of used instruments and devices, operatory care is performed on clinical contact surfaces and housekeeping surfaces (collectively, environmental surfaces). Keeping treatment areas uncluttered makes cleaning and disinfecting easier.

**Clinical Contact Surfaces**

Clinical contact surfaces include chairs, light handles, countertops, radiographic equipment, dental units, bracket tables, drawer handles, operatory computer equipment, and containers for multidose materials.

Microorganisms can remain viable on untreated exposed surfaces for days or months, depending on conditions and the microorganisms, posing a risk for disease transmission. Contamination of clinical contact surfaces in dental offices has been documented, including with MRSA, Viridans Streptococci, and other organisms. Associated indirect transmission of MRSA has occurred, and hepatitis B transmission from one patient to another patient treated was theorized to have involved contaminated clinical contact surfaces. Cleaning and disinfecting are required for all exposed clinical contact surfaces that were not covered with barrier protection and for those where barrier protection was compromised.

**Cleaning and Disinfecting Clinical Contact Surfaces**

**Selecting cleaners and disinfectants**

Cleaning is necessary in order to remove debris prior to disinfection, as it would otherwise prevent the disinfectant from reaching the underlying surface and inactivating microbes. Disinfection of clinical contact surfaces must be performed using an EPA-registered chemical disinfectant acceptable for this purpose. These have an EPA registration number that must be 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. EPA-registered surface disinfectants 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, nor may glutaraldehyde, because of the noxious and toxic vapors it releases.

An intermediate-level, EPA-registered disinfectant (one with tuberculocidal activity and a TB kill time on the labeling) must be used if visible blood is present. With the exception of spores, mycobacterium tuberculosis is the most resistant organism – if this is killed, so are all less resistant organisms. 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 product and can be found on the product labeling. A low-level EPA-registered disinfectant with an HIV and HBV claim is permitted if no visible blood is present; however, use of only an intermediate-level disinfectant has been recommended.

### TABLE 3. Persistence of microorganisms

<table>
<thead>
<tr>
<th>Microorganism</th>
<th>Potential persistence*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bordetella pertussis</td>
<td>3 – 5 days</td>
</tr>
<tr>
<td>Candida albicans</td>
<td>1–120 days</td>
</tr>
<tr>
<td>Enterococcus (includes vancomycin-resistant)</td>
<td>5 days – 4 months</td>
</tr>
<tr>
<td>Escherichia coli (E. coli)</td>
<td>1.5 hours – 16 months</td>
</tr>
<tr>
<td>HBV</td>
<td>Up to &gt; 1 week</td>
</tr>
<tr>
<td>HIV</td>
<td>Up to &gt; 1 week</td>
</tr>
<tr>
<td>Herpes Simplex</td>
<td>Hours and up to 7 days</td>
</tr>
<tr>
<td>Mycobacterium tuberculosis</td>
<td>1 day – 4 months</td>
</tr>
<tr>
<td>Pseudomonas aeruginosa</td>
<td>6 hours – 16 months</td>
</tr>
<tr>
<td>Staphylococcus aureus (includes MRSA: methicillin-resistant)</td>
<td>7 days – 7 months</td>
</tr>
</tbody>
</table>

*Length of persistence varies with conditions  
Source: Kramer EM, et al. BMC Infectious Diseases 2006
as blood present may not be visible and it saves having to carry two surface disinfectants in inventory. Surface disinfectants are available as solutions, sprays, and wipes. Prediluted solutions avoid exposure during mixing and the chance of incorrect dilution present with concentrates, but they require more inventory space.

**The process of cleaning and disinfecting**

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 1) there is no heavy soiling of the surface and 2) the chemical used contains both a disinfectant and a detergent. A two-step process can use the same product twice (if it is both a cleaner and a disinfectant) or use different products sequentially. 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. 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 as described below.

**Spray-Wipe-Spray**

The surface is sprayed first for cleaning either with a cleaner/disinfectant containing detergent or a separate detergent cleaning agent. Next the surface is wiped to remove debris and bioburden, after which the surface is sprayed with the disinfectant (or cleaner/disinfectant) and left to dry for the stated TB kill time on the labeling.

**Wipe-Throw-Wipe**

A cleaner (detergent) wipe or cleaner/disinfectant wipe is first used to clean the surface and thrown away, and then a second wipe is performed using a disinfectant or cleaner/disinfectant wipe. The surface is left for the required TB kill time. As with sprays, if using the same product for both steps, it must contain both a detergent and a disinfectant. Wipes use the least amount of chemical – reducing exposure and the risk of aerosolization/inhalation. If using impregnated wipes, check that the wipes contain sufficient liquid to cover the surface and remain wet for the required TB kill time. The size of the surface area for which a single wipe is used must be in accordance with the labeling.

**Swapping out barrier protection**

Barrier protection must be removed and replaced after each patient. If the barrier protection was torn or damaged during use or removal, the underlying surface is contaminated and must be cleaned and disinfected before placing new barrier protection on clinical contact surfaces for the next patient.

**Housekeeping Surfaces**

Housekeeping surfaces include sinks, floors, doors, walls, and blinds. Floors should be cleaned daily with fresh water and detergent or cleaned and then disinfected with fresh EPA-registered disinfectant solution if infectious body fluids, patient materials, or diluted body fluids are present. A dry, clean mop/cloth should be used (or a single-use mop/cloth). Walls, windows, and curtains should be cleaned when they are visibly dirty/dusty.

**Suction Lines**

Flushing out suction lines between patients does not treat biofilm; however, doing so for 20 seconds–30 seconds can help to reduce the presence of patient fluids and the level of microorganisms present.

**Instrument Processing**

Instrument processing involves systematic steps that consider occupational safety, the instruments themselves, equipment and packaging, sterilization assurance, and storage/inventory management. The overall goal of in-
Instrument processing is to have sterile instruments for all patient care. The instrument processing area should have a “dirty” area designated for the arrival of contaminated patient care items and a “clean” area where processed instruments are received into inventory. Adequate ventilation must be present in the processing area. A systematic, sequential workflow from dirty to clean avoids the risk of confusing or mixing sterile and contaminated instruments. Sufficient space should be available to allow for areas for receiving, cleaning, packaging, and sterilization. Storage may occur either in a clean, dry storage area on the clean side of the space or in a separate storage area. Following the arrival of contaminated instruments in the instrument processing area (and after any remaining waste or single-use items have been appropriately disposed of), the sequential steps involved in instrument processing are 1) sorting of instruments and selective presoaking, 2) cleaning, 3) instrument preparation/packaging, 4) sterilization, and 5) storage.

**Step 1. Sorting and Soaking**

Contaminated cassettes/trays and instruments are sorted, and handpieces are removed for separate preparation. Handpieces should be prepared per the handpiece manufacturer’s instructions before being heat-sterilized. Hinged instruments should be unlocked and opened prior to processing. Instruments that will sit for a period of time prior to cleaning and sterilization should be soaked in a presoak solution/spray to help prevent debris from drying on the instruments, which would make cleaning more difficult. If debris has already dried on instruments, these should also be soaked before cleaning. Closed perforated cassettes (or loose instruments) should be placed in a soak container and then the presoak solution or enzymatic spray added to fully coat the instruments. If a foam product is being used, sufficient foam must be sprayed over the instruments to allow for complete coverage after shrinkage of the foam. Enzymatic solutions/foams begin dissolving blood, protein, carbohydrates, fat, and other organic tissue and help to break down bioburden. Some foams that are marketed as nonenzymatic have a near-neutral pH (slightly alkaline) and are formulated to break down bioburden. In general, however, nonenzymatic foams and solutions do not help to break down bioburden. If necessary, check with the manufacturer. Foams are easier to use than solutions and less likely to result in spillage, and there is no need to store bulky solutions or dilute liquid concentrates.

Liquid solutions are available that can be used as presoaks in ultrasonic cleaners and instrument washers/disinfectors and for evacuation lines. In deciding what to use, factors to consider include whether bioburden will be broken down; how instrument-friendly it is; whether it is a concentrate or ready to use (consider inventory requirements, storage space, risk of spillage, and chemical exposure); ease of use; pH; and, specifically for foam, how quickly it will dissipate and whether it will maintain coverage over instruments. Presoaking together with ultrasonic cleaning was found in one series of tests to result in more effective cleaning than ultrasonic cleaning alone. Presoaking should be relatively brief and the manufacturer’s instructions followed to reduce the possibility of corrosion/rusting of non-stainless steel metal instruments (e.g., burs).

**Step 2. Cleaning**

Instruments must be cleaned to remove debris and bioburden prior to preparation/packaging and sterilization. Options include manual cleaning or mechanical cleaning (ultrasonic cleaners, instrument washers or washers/disinfectors). Mechanical cleaning by ultrasonic cleaners and instrument washers or washers/disinfectors is supe-
rior to manual cleaning for debris removal and reduces handling. Manual cleaning/scrubbing of contaminated instruments should be avoided if possible to reduce the risk of injury or being exposed to splash/splatter that could result in disease transmission. If manual scrubbing is necessary – for example, if residual debris is still present after mechanical cleaning – this should be performed at arm’s length, low in the sink using a long-handled brush and underwater (and while wearing heavy-duty utility gloves, a mask, and protective eyewear).

Ultrasonic cleaning

When using an ultrasonic cleaning machine, the machine generates sound waves, causing the solution to bubble. Cleaning occurs when the bubbles implode against the surfaces of the instruments (cavitation). Factors in choosing ultrasonic cleaners include their volume (size) for the anticipated instrument loads, their design, processing-area space requirements and whether the space is countertop or under the counter, the machine’s power and noise levels, testing and reliability, and ease of use. All of the manufacturer’s instructions must be followed. Closed cassettes should be placed on a tray or rack inside the machine, and loose instruments should be placed in a basket. Do not place cassettes or loose instruments in contact with the bottom of the ultrasonic cleaner as bubbles would not be able to reach and cavitate against the instruments/cassettes where they contact the base of the ultrasonic cleaner. Only one or two layers should be stacked in the ultrasonic cleaner to enable cleaning. After loading, the ultrasonic cleaner’s lid should be closed before the cleaner is turned on, to ensure that no solution sprays out. Instruments should not be added to batches of instruments already being cleaned. After treatment, cleaned instruments are removed and rinsed under running water to remove the cleaning solution (prevents instrument spotting, staining, and pitting) and then allowed to dry before being prepared/packaged for sterilization. Ultrasonic cleaners have been found to be superior to washers/disinfectors for cleaning endodontic files, possibly due to the shape of the instrument holder or complexity of the file’s surface area.

Tips for Effective Ultrasonic Cleaning
- Place cassettes in a tray or rack in the machine
- Place loose instruments in a basket
- Place only one or two layers of perforated cassettes in the ultrasonic cleaner
- Avoid overloading the ultrasonic cleaner
- Use an ultrasonic cleaning solution that is gentle on instruments while being able to reduce bioburden
- Keep the lid on the ultrasonic cleaner while it is in use
- Rinse all cleaned instruments under running water and allow to dry
- Discard and replace ultrasonic cleaning solution at least daily and more often if bacterial loads are high or if visibly dirty
- Do not add instruments to others already being cleaned
- Do not place cassettes or loose instruments in the base of the ultrasonic bath
- Never top off ultrasonic cleaning solutions

Ultrasonic cleaning solutions

Ultrasonic cleaning solutions or dissolving ultrasonic tablets are used – water is not an ultrasonic cleaning solution. Enzymatics remove bioburden; nonenzymatics are also available. A solution’s cleaning ability and instrument compatibility are important. Anticorrosive ultrasonic cleaners help protect non-stainless steel metal instruments and increase their useful life, while noncorrosive products will not damage them. Other factors to consider are the form of the solution (i.e., concentrate versus a prepared solution or tablets), cost-effectiveness, and scent. Ultrasonic solutions must be discarded and replaced at least daily. If bacterial loads are higher due to more heavily contaminated instruments or larger/more-frequent instrument loads are cleaned, then the solution must be changed more frequently. Ultrasonic solutions should never be topped off in lieu of fully replacing the solution.

Instrument washers and washers/disinfectors

Instrument washers and washers/disinfectors are FDA-regulated medical devices that involve less handling of contaminated instruments than do ultrasonic cleaners or
manual cleaning, reducing the risk of injury and cross-contamination. Washer and washer/disinfector cycles provide for cleaning, rinsing, and drying – washers use hot water and detergent, while washers/disinfectors use high-temperature water and disinfectants that result in cleaned and disinfected instruments with less debris. The detergent/disinfectant recommended by the manufacturer must be used and the manufacturer’s instructions followed. After cleaning, rinsing, and drying, instruments are ready for inspection to ensure that they are free of damage and debris before entering the next phase of instrument processing. Regular dishwashers are not medical devices and may not be used as a substitute for a washer or washer/disinfector.

**Step 3. Instrument preparation and packaging**

The sterilization process for specific instruments (and the associated preparation/packaging) is based on Spaulding’s classification (Table 4). All critical instruments, heat-resistant semicritical instruments, and handpieces must be heat-sterilized. Semicritical instruments that are heat-sensitive – with the exception of handpieces – and noncritical instruments may be sterilized with a high-level sterilant/disinfectant. It is essential to understand which instruments can undergo mechanical cleaning, tolerate use of disinfectant/sterilant, or need to be disassembled for processing. For example, some lasers have been designed with fully autoclavable tips, spools, and sleeves, while others may have disposable tips and other components that are autoclavable. These attributes are considerations when purchasing equipment, and the protocol for an instrument must be known to ensure appropriate processing.

Cleaned, dry instruments and cassettes should be packaged before being heat-sterilized. Only FDA-cleared sterilization packaging may be used – paper/cloth towels are not a substitute for sterilization packaging. Sterilization packaging serves several functions: 1) the external and internal indicators used with the packaging verify sterilization parameters (see below); 2) there is no risk of later confusing contaminated instruments with packaged, sterilized instruments; and 3) sterile instruments will remain uncontaminated in intact packaging post-sterilization until needed, provided they are handled and stored correctly. In contrast, unpackaged loose instruments are handled immediately after sterilization – they are subject to contamination from that point on.

Sterilization packaging must be strong enough for routine use, have an adequate seal, allow penetration of the sterilant, and remain intact during subsequent storage. The choice of packaging depends on the type of heat sterilizer, what is being packaged, and personal preference. Options include FDA-cleared paper wrap, paper pouches, paper/plastic pouches, and plastic pouches and tubing. Plastic, plastic/paper pouches, and plastic tubing are used for cassettes, instruments, and handpieces. These enable identification of both the contents and the status of internal indicators. Self-sealing pouches offer ease of use. Paper and paper/plastic pouches are contraindicated for 1) loose sharp instruments, because of the risk of perforation; and 2) dry-heat sterilizers, as the plastic/paper pouches may separate, scorch, or melt.

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**TABLE 4. Spaulding’s classification**

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical</td>
<td>Penetrate soft tissues, bone, normally sterile tissues</td>
<td>Heat-sterilize</td>
</tr>
<tr>
<td>Semi-critical</td>
<td>Contact mucous membranes, nonintact skin&lt;br&gt;Do not penetrate hard or soft tissues</td>
<td>Heat-sterilize if heat-resistant&lt;br&gt;Heat-sterilize handpieces&lt;br&gt;If heat-sensitive:&lt;br&gt;High-level disinfectant/sterilant</td>
</tr>
<tr>
<td>Noncritical</td>
<td>Contact intact skin</td>
<td>EPA-registered disinfectant</td>
</tr>
</tbody>
</table>

Sources: Guidelines for infection control in dental healthcare settings—2003 (CDC); Guideline for disinfection and sterilization in healthcare facilities—2008 (CDC).
during exposure to the high temperatures generated.\textsuperscript{46} If dry-heat sterilization is being performed, packaging that is FDA-cleared specifically for this purpose must be used. If in doubt, check with the manufacturer on the intended use of specific sterilization packaging. Paper wrap is used routinely for cassettes, with an internal indicator and heat-sensitive tape for closure. Staples, pins, and other closure methods that pierce the packaging may not be used, as they compromise it and permit recontamination of instruments. All sterilization packaging must include an internal indicator, and if this is not visible (for example, in a paper wrap), then an external indicator must also be used. The sterilizer used and date/cycle information should be placed on the external surface of the packaging for identification purposes.

**Chemical indicators**

There are six classes of chemical indicators used with sterilization packaging/processing. These indicate whether malfunctioning occurred during sterilization (including as a result of operator error). Class I and II indicators are external indicators. A Class I indicator is required if an internal indicator is not visible. It indicates only that the package was exposed to the process. Class II indicators (the Bowie-Dick or air-removal test) are required specifically for dynamic air removal (Class B) sterilizers and must be used in a test pack at the beginning of each day in an otherwise-empty sterilizer.\textsuperscript{47} Classes III, IV, V, and VI indicators are internal. Internal indicators should be placed adjacent to the instruments to ensure that they are measuring the parameters where these are located. This is especially important for larger sterilization packages. The Class VI indicator reacts to all three variables – time, temperature, and the presence of saturated steam – for a specific sterilization cycle and verifies the cycle; Class V integrating indicators react to all three variables over a range of temperatures. The main difference between a Class III and Class IV internal indicator is that the Class IV is designed to react to two or more variables rather than to only one, at stated values for the given variables. These meet the packaging internal indicator requirement and are built into some sterilization pouches – this saves time and inventory and prevents forgetting to use an indicator. If any in-use indicator fails, the load must be repackaged and reprocessed. **Chemical indicators do not indicate whether sterility has been achieved, only that the process met the parameters being measured for the specific indicator.**

**Step 4. Heat Sterilization**

Heat sterilization is achieved by autoclaving, dry-heat sterilization, or chemical sterilization (chemclave) with cycle times varying depending on the method of sterilization, cycle, and specific sterilizer. Instrument loads must be placed with sufficient space between them to allow penetration of the sterilant through sterilization packaging. The sterilizer must not be overloaded, and the manufacturer’s instructions must be followed. All heat sterilizers are FDA-regulated medical devices and must pass rigorous testing. Mechanical indicators on sterilizers confirm that a specific parameter was reached (such as temperature or pressure). These may be mechanical or electronically controlled gauges. In some devices, the parameters can be printed; if so, the printout for each cycle should be kept in the sterilization log. Mechanical indicators provide immediate feedback and indicate only that the sterilizer was functioning, not whether sterilization has occurred.
**Autoclaves**

Autoclaves use a combination of heat and pressure to generate steam that sterilizes instruments by denaturing microbes’ proteins. Cassette racks for horizontal or vertical loading help to prevent overloading. All autoclaves require the use of distilled water to prevent potential spotting on instruments or cassettes and the buildup of mineral deposits on the autoclave chamber and in its pipes. Autoclaves operate using dynamic air removal or gravity displacement. Dynamic air removal autoclaves (vacuum autoclaves) first remove air using an electronically controlled vacuum pump or valve, after which steam enters the chamber. Compared with the gravity displacement autoclave, this process removes more air and improves steam penetration into dental handpiece turbines. With the gravity displacement autoclave, steam enters the chamber from the sides and top of the chamber and pushes air out through a vent in the base of the chamber. After autoclaving, loads must remain in the autoclave with the door still closed until depressurization and drying of the packaging has been completed. Packaging removed while still damp can wick and become contaminated. Typical cycle times and temperatures for gravity displacement and dynamic air removal autoclaves are, respectively, 15 to 30 minutes at 250°F (121°C) and 3.5 to 10 minutes at 270°F (132°C). This does not include warm-up pressurization time or the time required for depressurization and the drying cycle. Autoclaving can result in corrosion/pitting of non-stainless steel metals – carbon-steel instruments/devices can be treated with rust inhibitors to help prevent this.

**Chemclaves**

Chemclaves typically operate at 270°F (132°C), with a cycle time of 20 minutes. Their use reduces the risk of corrosion/pitting of instruments, and the instruments are dry after the cycle. Although faster than autoclaves and using lower temperatures than those used in dry-heat sterilization, their use of proprietary formaldehyde-alcohol-based chemicals increases exposure to chemicals in the office.

**Dry-heat sterilizers**

Dry-heat sterilizers operate at high temperatures. The cycle time varies, ranging from 6 minutes to up to 2 hours, and since there is no drying time required, the packaged instruments are then ready for removal and storage. Typical cycle times and temperatures for static and convection dry-heat sterilizers are, respectively, 60 to 120 minutes at 320°F (160°C) and 6 to 12 minutes at 375°F (190°C). Dry-heat sterilization eliminates the risk of instrument corrosion/pitting. However, their high temperature cycles are more likely than other heat sterilizers are to damage and degrade instrument O-rings and plastic cages (contained in handpiece turbines) as well as other plastics.

**Biological indicators (spore tests)**

Biological indicators should be used in heat sterilizers at least weekly and every time an implantable device is being sterilized. This is the only method by which sterility assurance can be obtained. Spores are the most resistant microorganisms and if killed, so are all other (less resistant) microorganisms. Both test and control biological indicators are used – the test indicator is placed inside the sterilizer, while the control one is left outside the sterilizer. The test is deemed valid only if the spores outside the sterilizer are still alive and the sterilized ones are not. Spore test kits can be used in-office, or sent to a laboratory for verification of sterility assurance, or both (ie, in-office together with periodic laboratory spore tests). All data must be recorded before the spore test is performed, including the load number, sterilizer number, and processing date. This data should be placed on the spore
Pathways to Infection Prevention

Heat-Sensitive Semicritical and Noncritical Instruments

High-level FDA-cleared disinfectants/sterilants (not surface disinfectants) may be used for heat-sensitive semicritical instruments (except handpieces) and for noncritical instruments. These destroy all microorganisms (including spores) in a given length of time. Soaking trays are also available for use with high-level disinfectants/sterilants. Chemicals meeting the requirements of a high-level disinfectant/sterilant include 7.5% hydrogen peroxide solution (sterilizes in 6 hours of immersion), phenol solutions and 8% peracetic acid. The manufacturer’s instructions must be followed and compatibility with instrument materials verified. Tests showing whether a solution is still active and above the minimum effective concentration are available for some disinfectant/sterilants, including 7.5% hydrogen peroxide. Tests cannot be performed to assure sterility with high-level disinfectants/sterilants.

Handpieces

All handpieces must be heat-sterilized. Although sensitive to heat-sterilization, with improvements in bearing design, longevity is now influenced more by lubrication, corrosion protection, and running them at low loads. Failure to properly implement these is significantly more detrimental to handpieces than is heat-sterilization.49,50 Following the handpiece manufacturer’s instructions for cleaning, sterilization, and lubrication avoids damage and voiding of the handpiece warranty. General procedures for the processing of handpieces are as follows:

- Remove burs
- Wipe the external surface of the handpiece to remove debris

- Do not immerse handpieces in solution unless permissible by the handpiece manufacturer
- Do not place handpieces in an ultrasonic bath
- Place the handpiece in FDA-cleared sterilization packaging and heat-sterilize the handpiece

Step 5. Storage

Heat-sterilized instruments and devices should be stored in their unopened sterilization packaging in a dry, dust-free storage area until needed. Studies of up to 6 months have found no contamination of test groups of autoclaved or dry-heat-sterilized instruments that had been stored in their intact sterilization packaging in a closed, dry area post-sterilization.51,52 Cold-sterilized instruments should be dried, segregated, and stored in a dry, enclosed area.

Oral Radiology Equipment

Digital sensors, traditional film, bite guides, X-ray holders, positioners, and sensor holders all contact intact oral mucosa and are thus semicritical devices. Depending on the item, it may be single-use disposable or nondisposable. Sensor holders, positioners, and bite blocks are now available that can be safely autoclaved – this is reliable, recommended over high-level disinfection or barrier protection plus surface wipe disinfection, and reduces the use of chemicals. If they are not disposable/autoclavable/immersible, barrier protection followed by cleaning and use of an intermediate-level surface wipe disinfectant is another option. Digital sensors should be placed in preshaped barrier protection or wrapped in barrier film. In the case of phosphor plates, one study concluded that barrier sheaths did not reliably prevent cross-contamination and that barriers and subsequent disinfectant should be used.53 For traditional film, FDA-cleared barrier pouches designed for X-ray film packets should be placed over it prior to use, or film in prepacked barrier envelopes should be used. Barrier protection should be removed without touching the underlying object and the object then cleaned and treated with an intermediate-level disinfectant wipe. Traditional film packets can be aseptically dropped out of barrier protection onto a clean cloth/towel surface while removing barrier protection, before transportation for film processing. Using clean (i.e., unused) medical gloves during the
loading of traditional film into processors reduces the risk of cross-contamination.

Disinfecting Impressions
Impressions must be cleaned and disinfected. The general procedure is as follows:
- Clean the impression immediately after taking it, before blood/bioburden can dry on it
- Disinfect the impression using an EPA-registered hospital-level disinfectant with a tuberculocidal claim
- Rinse the impression under running water – failure to properly rinse off the disinfectant can result in a substandard model because of the incorporation of residual disinfectant.

Alginates can be cleaned, sprayed with disinfectant, or wrapped in a disinfectant-soaked towel and then placed in a sealed plastic bag for the recommended time (10 minutes) before rinsing off. If alginates are disinfected by immersion, the time must not exceed 10 minutes to avoid dimensional and surface changes. For nonaqueous elastomeric impression materials, a spray technique or immersion in disinfectant (provided the immersion time required is compatible with the impression material) can be used. Disinfectants variously recommended by impression material manufacturers include iodophors, 5.25% sodium hypochlorite diluted 1:10, and 7.5% hydrogen peroxide. The impression material manufacturer’s recommendations on the type of disinfectant and immersion time must be followed. The laboratory should be given written information on what disinfection was performed.

End of day
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 during patient care. This is the same cleaning and disinfecting procedure described earlier in this article.

Evacuation Lines
Evacuation lines include the saliva ejector (low-speed suction), high-speed suction line, and cuspidor. Saliva ejectors typically do not have antiretraction valves and provide low-volume suction. Therefore, patients should be instructed not to close their lips over saliva ejector, to avoid backflow and dislodging of biofilm. At the end of each day, all evacuation lines must be flushed with a cleaner to help reduce debris and the number of microorganisms. Chemicals used to clean evacuation lines remove deposits and debris, deodorize, and clean. They also help prevent the buildup of deposits, including calcium. 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.

Dispenser systems are available that simplify evacuation line disinfection in the multichair dental office. Such dispensers can be filled with sufficient cleaner for two or three operatories, with measuring lines that indicate the amount required for each operatory. The mixing of air and solution also minimizes pressure on the pump. 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 with continuous flow of the solution and removal of debris through the whole system; if the vacuum were to be turned off in the middle of the line, this would allow debris to flow away from the pump and remain in the lines after cleaning. Always follow the manufacturer’s recommendations.

Amalgam separators are a component of the ADA Best Practices on amalgam handling and remove amalgam and other solids from evacuation lines. If using an amalgam separator, to ensure its proper working and to prevent the release of mercury from amalgam or early wear of the separator, it is important to use a neutral pH cleaner (avoid acidic or highly alkaline cleaners). Whether or not an amalgam separator is present, the use of chlorine-containing evacuation line cleaners (and bleach) should be avoided.

Dental Unit Waterlines
Dental unit waterlines (DUWs) are the narrow-lumen tubing used to convey water to handpieces, ultrasonic scalers, and air-water syringes during treatment, as well as for rinsing. Options for maintaining and improving the quality of DUW
water include point-of-use filters, microfiltration for each outlet, water purifiers using silver ions or iodine, daily draining and air purging, independent water systems, and chemical treatments. Recently, new technology has been introduced that utilizes an autoclavable cassette system that involves sterilization of the water, water container, and waterline tubing for the handpiece and air and water syringe. Depending on the selected option, dental unit waterline treatment frequency varies considerably. The manufacturers of specific dental unit waterline treatments provide recommendations and protocols for the use of their products.

**Summary**

Following infection control procedures involves procedures at the beginning of the day; before, during, and after patient care; and at the end of the day. The success and safety of infection prevention depends on following a standardized, repeatable, and reliable protocol that meets the CDC guidelines and OSHA requirements. Safe care and effective infection prevention protects patients, dental healthcare workers, and the community at large.

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Webiography
Centers for Disease Control and Prevention. Guidelines for Infection Control in Dental Health-Care Settings – 20 03. Available at: http://www.cdc.gov/mmwr/PDF/rr/rr5217.pdf
CE Quiz

1. The chain of infection comprises __________ elements.
   a. four
   b. five
   c. six
   d. seven

2. Host susceptibility depends on __________.
   a. a person’s health
   b. the neighbors
   c. vaccination status
   d. a and c

3. All employees in dental offices must be offered __________ vaccinations by the employer.
   a. hepatitis B
   b. MMR
   c. hepatitis C
   d. all of the above

4. Hand hygiene is __________.
   a. the single most important factor in preventing disease transmission
   b. performed with the objective of removing the resident flora
   c. required only if hands are soiled
   d. all of the above

5. Keeping fingernails (or artificial nails) short and smooth __________.
   a. makes hand hygiene under nails easier
   b. is not an official requirement
   c. reduces the risk of glove puncture
   d. all of the above

6. Compliance with hand hygiene can be improved by __________.
   a. using soap containing an emollient
   b. avoiding hand hygiene products with ingredients that a user may be allergic to
   c. selecting products that feel and smell pleasant
   d. all of the above

7. Operatory personnel must wear __________ for each and every patient.
   a. single-use medical or sterile surgical gloves
   b. eyewear, face masks and clinical attire
   c. rubber boots
   d. a and b

8. Heavy-duty utility gloves are required for __________.
   a. operatory clean-up
   b. instrument processing
   c. treatment of evacuation lines
   d. all of the above

9. The use of barrier protection for disinfection __________.
   a. may better protect areas that are more difficult to access
   b. saves time
   c. reduces the need for cleaning and disinfesting with chemicals
   d. all of the above

10. The Centers for Disease Control and Prevention recommends the use of single-use, disposable patient care items when possible to reduce the risk of __________.
    a. cross-contamination and disease transmission
    b. puncture wounds
    c. antimicrobial resistance
    d. a and b

11. Sharps disposal chairside reduces the risk of __________.
    a. contaminating surfaces
    b. percutaneous injuries
    c. mislabeling patient care items
    d. none of the above

12. OSHA is charged with protecting the health and safety of __________ in the United States.
    a. all workers
    b. the entire community
    c. children
    d. all of the above

13. Waste contact and noncontact amalgam must be __________.
    a. “gray bagged”
    b. labeled
    c. sent to an authorized vendor
    d. all of the above

14. __________ can be placed in presoaks and ultrasonic cleaners or washers/disinfectors for cleaning prior to packaging and sterilization.
    a. Closed, nonperforated cassettes
    b. Motors
    c. Closed, perforated cassettes
    d. any of the above

15. Enzymatic solutions/foams begin dissolving __________.
    a. organic tissue
    b. inorganic deposits
    c. blood, protein, carbohydrates, fat
    d. a and c

16. A(n) __________ must be used on clinical contact surfaces if visible blood is present.
    a. high-level disinfectant
    b. low-level, EPA-registered disinfectant
    c. intermediate-level, EPA-registered disinfectant
    d. any of the above
CE QUIZ

17. All sterilization packaging must include ___________.
   a. an internal indicator
   b. an external indicator if the internal indicator is not visible
   c. a biological indicator
   d. a and b

18. _______________ indicate that sterility has been achieved.
   a. External indicators
   b. Class IV internal indicators
   c. Biological indicators
   d. all of the above

19. A one-step process combining cleaning and disinfecting of clinical contact surfaces may be used if ___________.
   a. there is no heavy soiling of the surface
   b. the chemical used contains both a disinfectant and a detergent
   c. only a very small surface area is present
   d. a and b

20. If using impregnated wipes to clean and disinfect clinical contact surfaces, check that the wipes contain sufficient liquid to ___________.
    a. cover the surface
    b. remain wet for the required TB kill time
    c. drip on the floor
    d. a and b

21. The overall goal of instrument processing is ___________ for all patient care.
    a. clean instruments
    b. sterile instruments
    c. fresh supplies
    d. any of the above

22. Using a presoak for instruments that will sit for a period of time prior to cleaning and sterilization helps to ___________.
    a. prevent debris from drying on them
    b. kill bloodborne pathogens
    c. prevent corrosion
    d. all of the above

23. Cleaning is necessary in order to ___________ from clinical contact surfaces, as it would otherwise prevent disinfectant from reaching the underlying surface and inactivating microbes.
    a. remove debris
    b. decontaminate surfaces
    c. ensure no pathogens remain
    d. all of the above

24. When using an ultrasonic cleaner ___________.
    a. only one or two layers should be stacked in it
    b. instruments must not be added during the cleaning process
    c. the ultrasonic cleaner’s lid should be closed before the cleaner is turned on
    d. all of the above

25. All ___________ must be heat-sterilized.
    a. critical and semi-critical instruments
    b. critical, semi-critical and noncritical instruments
    c. critical instruments, heat-resistant semicritical instruments, and handpieces
    d. noncritical and semi-critical

26. The choice of FDA-cleared sterilization packaging depends on ___________.
    a. what is being packaged
    b. the type of heat sterilizer
    c. personal preference
    d. all of the above

27. High-level FDA-cleared disinfectants/sterilants may be used for ___________.
    a. critical instruments
    b. heat-sensitive semicritical instruments
    c. handpieces
    d. clinical contact surfaces

28. The general procedure for cleaning and disinfecting impressions is to ___________.
    a. clean the impression immediately after taking it
    b. disinfect the impression using an EPA-registered hospital-level disinfectant with a tuberculocidal claim
    c. rinse the impression under running water
    d. each one of the above

29. At the end of each day, ___________.
    a. all evacuation lines must be flushed with an evacuation line cleaner
    b. all traps must be cleaned
    c. all clinical contact surfaces must be cleaned and disinfected
    d. all of the above

30. The success of infection prevention depends on following a ___________ protocol that meets all regulations, guidelines and recommendations.
    a. standardized
    b. repeatable
    c. reliable
    d. all of the above
CE ANSWER FORM (E-mail address required for processing)

<table>
<thead>
<tr>
<th>Name:</th>
<th>Title:</th>
<th>Specialty:</th>
</tr>
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City: State: Zip: |

Practice Name: |

EDUCATIONAL OBJECTIVES
- Describe the chain of infection and modes of transmission
- List the elements involved in the daily infection prevention cycle
- Review the importance of hand hygiene, appropriate procedures, and factors that influence compliance with hand hygiene
- List and describe the steps involved in the treatment of clinical contact surfaces
- Delineate each step in instrument processing
- Describe the activities necessary at the beginning and end of each day.

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