Circling In On Infection Prevention

A Peer-Reviewed Publication
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Publication date: January 2011
Expiry date: December 2013

This course has been made possible through an unrestricted educational grant. The cost of this CE course is $59.00 for 3 CE credits.

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Educational Objectives
The overall goal of this course is to provide the reader with information on infection prevention in the dental office. Upon completion of this course, the reader will be able to do the following:
1. List and describe the overall steps involved in infection prevention in the dental office and their sequencing for patient care.
2. List and describe appropriate personal protective equipment (PPE) as well as other steps clinical and administrative staff can take to protect themselves.
3. Describe the treatment of clinical contact surfaces.
4. Describe the work flow and processing of instruments.
5. List and describe the procedures that must be performed at the end of each day.

Abstract
Infection prevention is a key process in the dental office for the protection of patients and dental healthcare workers. The cycle of infection prevention is aimed at breaking the chain of infection, achieved by following a rigorous process with a series of clearly-defined steps. Only if the process is followed can there be an assurance of adequate infection control in the dental office setting.

Introduction
Infection prevention is mandatory in the dental office to protect clinicians, dental office staff and patients. This protocol must meet both the recommendations of the Centers for Disease Control and Prevention (CDC) and the requirements of the Occupational Safety and Health Administration (OSHA) and must follow OSHA’s Bloodborne Pathogens Rule. OSHA also regulates the disposal of sharps and waste.

The CDC issued Standard Precautions in 1996 (subsequent to its Universal Precautions, issued in 1987) and in 2003 published its “Guidelines for Infection Control in Dental Health-Care Settings – 2003.” Standard Precautions apply to contact with all body fluids except sweat, mucous membranes and open wounds in skin, which are all considered to be sources of pathogens and infection. All patients, not just those who are perceived or known to be high-risk sources of infection or who have signs and symptoms of infectious diseases, must be regarded as potential sources of infectious pathogens. Thus, Standard Precautions must be followed for all patients. The CDC has also recommended transmission-based precautions for patients who have specific diseases, including the use of isolation/quarantine and high-grade masks for respiratory protection.

The Food and Drug Administration (FDA) regulates drugs and devices, including high-level disinfectants/sterilants, sterilization equipment and packaging, and personal protective equipment. The Environmental Protection Agency (EPA) is responsible for registering intermediate-level and low-level surface cleaners and disinfectants. The steps involved in infection prevention can be broken down in sequence – those that must occur before a patient enters the clinical setting, those that must occur while the patient is being treated, and those that must occur after the patient has left the office and before the next patient is seen. Core elements of the infection prevention protocol are repeated sequentially throughout the day. In addition, certain tasks must be performed at the end of each day. The overall objective is to break the chain of infection in order to prevent cross-contamination and cross-infection and, thereby, to prevent disease.

The Chain of Infection
Each step of the infection prevention cycle is critically important; if one step is not followed, the chain of infection will not be broken, placing patients and healthcare professionals at risk for cross-infection and disease. The chain of infection requires that a number of elements are present. These are: the presence of a pathogen at a level sufficient to cause disease, a source/reservoir for that pathogen, a mode of transmission for the pathogen, a point through which the pathogen can enter a host, and a host that is susceptible to the transmitted pathogen. The source/reservoir for the pathogen can be an inanimate object (such as an operatory surface or a dental instrument) or a human being (a patient, a member of operatory personnel or non-operatory staff). Disease transmission can occur through direct or indirect contact with the pathogen, spatter or aerosols.

Direct contact occurs through exposure to an infected area or infected body fluid. Indirect contact occurs through spatter, aerosols or contact with inanimate objects that have become contaminated (such as patient care instruments or clinical contact surfaces). Direct contact protection involves the use of personal protective equipment. Indirect contact is also prevented through the use personal protective equipment, as well as by using operatory surface barriers, surface disinfection, disposables and single-use instruments, and appropriate instrument processing and sterilization.

Figure 1. The five elements of the chain of infection
General Precautions – Reducing Host Susceptibility

Reducing host susceptibility is one of the methods that helps break the chain of infection. Recommendations on healthcare worker immunizations were published by the CDC in 1997 (“Immunization of Healthcare Workers”). For dental healthcare personnel in general, vaccination is recommended against hepatitis B, influenza, measles, mumps, german measles and chicken pox. Note that special considerations, precautions and contraindications exist for certain individuals for specific vaccines that can preclude or delay their use. In an ideal world, all patients would also have been immunized, or have acquired immune status, against these diseases; however, this may or may not be the case. Employers in healthcare settings, including dental offices and clinics, must offer the hepatitis B vaccination to employees and must maintain records of inoculation status for all staff.

Patient Care

Steps in the infection prevention protocol begin before a patient enters the office and end after the last patient has left for the day. Prior to a patient entering the operatory, clinical contact surfaces must have been cleaned, disinfected and prepared after the departure of the previous patient. If the patient is the first patient of the day, all surfaces should have been cleaned and disinfected the day before, after the last patient had left. The steps involved starting with preparation for an arriving patient are as follows: preparation of the dental operatory, preparation of operatory staff, patient care, disposal of sharps, cleaning and disinfecting of clinical contact surfaces and instrument processing. This process then circles back to preparation of the operatory for the next patient.

Preparing the Dental Operatory

Prior to a patient entering the operatory for treatment, all surfaces must be prepared. Barrier protection guards surfaces from contaminants, reducing the risk that pathogens will gain access to operatory surfaces and the possibility of subsequent disease transmission through indirect contact with contaminated surfaces. This is addressed in the post-patient/pre-patient phase of the cycle later in this article.

Preparing Clinicians and Assistants

Hand hygiene and the donning of personal protective equipment are required for clinicians and assistants prior to treating patients. Hand hygiene must be performed before donning gloves.

Hand Hygiene

Hand hygiene is the single most important element for the prevention of disease. This was recognized in the mid-1800s when it was discovered that thorough hand-washing prior to obstetric care reduced the risk of puerperal fever—a common cause of death in that era for mothers following delivery of their babies. Recommendations for hand hygiene in healthcare were issued by the CDC in 2002.

The main goal of hand hygiene is to remove flora that can transmit disease. Human skin contains two types of flora: transient and resident. The resident flora resides in the deeper layers of the skin; as such, it is not only more difficult to remove from the skin than transient flora, but also less likely to be associated with the transmission of disease. Transient flora in the outer layers of the skin, on the other hand, is easy to transmit and acquire through direct and indirect contact in the dental operatory.

Hand hygiene must be performed:
- Prior to donning gloves
- After removing gloves
- When changing out gloves during a procedure
- Following ungloved skin contact with patients
- Following ungloved skin contact with potentially contaminated inanimate surfaces

It is recommended that, prior to performing hand hygiene, rings and other jewelry be removed from the hand and wrist areas, to enable removal of microorganisms from these areas and to allow for thorough hand hygiene. It should be noted that there is no evidence on whether removing rings prior to hand hygiene procedures actually reduces the risk of cross-infection. It is recommended that nails be kept short, since high bacterial loads are found within the proximal 1 mm adjacent to the subungual skin on the underside of the nail area. Access to this area is improved with short nails that are also well-trimmed to prevent glove perforation by nails with ragged edges. While it is not known if artificial nails result in cross-infection in the dental office setting, transmission of bacteria and disease has occurred in other healthcare settings and the CDC recommends that

Figure 2. The infection prevention cycle

Prior to Patient Care
- Preparing the operatory
- Barrier protection
- Preparing clinicians and assistants
- Hand hygiene
- Personal protective equipment

After Patient Care
- Disposal of sharps
- Disinfection of lab work
- Removal of environmental barriers
- Clean and disinfect exposed contact surfaces
- Disposal of waste
- Instrument processing, storage

End of Day
- Clean and disinfect clinical contact surfaces
- Clean evacuation lines

During Patient Care
- Single-use disposables
- Personal protective equipment
- Aseptic technique
- Antimicrobial rinses
- Dental (rubber) dam
- Closed cassette systems
medical personnel not wear artificial nails when in direct contact with high-risk patients. The guidelines of the World Health Organization recommend that artificial nails should not be worn as hands can remain contaminated after hand hygiene if the user is wearing artificial acrylic nails. Chipped nail varnish can harbor microorganisms, therefore if nail varnish is worn it must be fresh and unchipped.

**Practicing hand hygiene**

The level of hand hygiene and the products required depend on two factors: the degree of contamination present on the hands and the procedure to be performed.

For nonsurgical procedures, if hands are not visibly contaminated with tissue or body fluids and have no debris on them, an alcohol-based hand rub can be used or an antimicrobial soap and water. If hands are visibly contaminated or have debris on them, hand washing is required (with either an antimicrobial soap and water or a nonantimicrobial soap and water). Handrubs will not remove debris. For surgical procedures, hand washing with antimicrobial soap with persistent activity or hand washing with plain soap and use of alcohol-based hand rub with persistent activity is essential prior to donning surgical gloves. In addition, hand washing should be performed at the start of the day.

Adequate hand washing involves rubbing the hands together with the soap and water for at least 15 seconds (and for surgical procedures, 2 to 6 minutes depending on the product). The most effective and quickest method of reducing the bacterial load on hands is use of an alcohol-based hand rub (60% to 95% ethanol; for surgical procedures, must also have ingredients for persistent activity). This has also been found to result in less dryness of the hands with repeated use, compared to using soap and water. When using an alcohol-based hand rub, personnel should apply it to one hand and then rub it all over both hands until they are dry. For all techniques and protocols, the manufacturer’s instructions for the product must be followed. After hand hygiene is performed, regardless of which method is used, hands must be thoroughly dry and contact with surfaces must be avoided before donning gloves. If towels are used to dry hands, these must be single-use, disposable.

**Figure 3. Hand hygiene**

**Nonsurgical procedures**
- No visible contamination
  - Hand washing - plain or antimicrobial soap and water
  - Antimicrobial soap and water
  - Alcohol-based rub

**Surgical procedures**
- Visibly contaminated
  - Antimicrobial soap with persistent activity and water
  - Plain soap and water and Alcohol-based rub with persistent activity

Active ingredients found in antimicrobial soaps include chloroxylenol; 2% and 4% chlorhexidine; iodophors: 0.3% triclosan; phenols; and quaternary ammonium. Using foam reduces the amount of the chemical/soap used, reducing the likelihood of skin dryness and irritation. Several antimicrobial soaps also contain skin emollients and other ingredients to help guard against dryness and to soothe the skin. Since dryness and skin irritation are two of the reasons given for noncompliance with hand hygiene protocols, use of a soap containing an emollient or a nondrying, alcohol-based hand rub (whichever is appropriate) offers a desirable benefit.

Other reasons given for noncompliance include lack of product availability and inconvenience of sink locations. Towelettes and liquid sanitizers remove the location issue from the equation. Antimicrobial towelettes are suitable only if plain soap and water would otherwise be appropriate; however, since they are not as effective in reducing bacterial loads as washing with an antimicrobial soap or using an alcohol-based hand rub, alcohol-based towelettes are not a substitute for these. Liquid and foam sanitizers containing alcohol and emollients are available, and some also contain 4% chlorhexidine gluconate. Using liquid- or foam-dispensed soaps in closed disposable containers reduces the risk of contamination; this type of system also dispenses an accurate amount of the product. These should not be topped off with additional product, however, as this can contaminate the soap. No-touch dispensers with sensors further reduce any risk of contamination of soap or sanitizer containers. When selecting hand hygiene products, one must consider the chemical ingredients, any contraindications for
individuals in the office (such as allergies), efficacy, ease of use, feel, preferences, moisturizing effect/skin hydration, presence of emollients and dispenser options.

**Skin Care**

Using hand lotions that contain emollients throughout the day, after performing hand hygiene, helps prevent skin dryness and irritation. There are lotions available that are formulated to be hypoallergenic, nongreasy and compatible with latex gloves. Note that mineral oil-based lotions and petroleum-based materials (such as Vaseline) are incompatible with latex gloves.

<table>
<thead>
<tr>
<th>Table 1. Lack of compliance with hand hygiene</th>
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<tr>
<td><strong>Reason given</strong></td>
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<td>Dry skin and irritations</td>
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<td></td>
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<tr>
<td>Poor sink location</td>
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<td></td>
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<tr>
<td>Dislike of feel/scent of product</td>
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<tr>
<td>Wearing of gloves, no need</td>
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**Personal Protective Equipment**

Personal protective equipment (PPE) prevents direct and indirect contact with pathogens during patient care, operative infection control procedures and instrument processing. It acts as a physical barrier for the skin, eyes, nose and mouth, protecting against splatter, aerosol and contact with inanimate objects, all of which can harbor harmful microorganisms. A bacterial aerosol, or bioaerosol, has been defined as existing when the particle sizes are less than 50 μm.14 The use of high-speed handpieces and ultrasonic scalers are particularly associated with the production of water spray and bacterial aerosols.15,16 High bacterial load aerosols and subsequent bacterial contamination of surfaces in the dental office have been found in studies.17,18 Hard objects can damage the eyes themselves. PPE includes protective clothing, masks, protective eyewear and gloves. Protective clothing is required to cover undergarments and skin, protecting these from direct and indirect contact as well as spatter.

**Masks**

Face masks must be worn, covering the nose and mouth to protect against aerosols and spatter. The more fluid-resistant the mask and the higher the filtration rating, the greater the level of protection for the operator. Filtration ratings are standardized by the American Society for Testing Materials (ASTM): the higher the rating, the greater the protection. In influenza epidemics, it has been recommended that NIOSH respirators rather than face masks be used, as part of transmission-based precautions (versus universal or standard precautions). Masks are available in several grades and many designs; they must be comfortable to wear and breathable, and they must fit snugly against the face and under the chin without any gaps. Pleated, unpleated and cone-shaped face masks are available. Hypoallergenic, dye-free masks are also available for sensitive skin. During patient care, if a mask becomes damp due to external fluids/spatter or due to moisture from the wearer’s breath or facial sweating, this will render it ineffective; the mask must be removed and replaced if this occurs. Mask selection should be based on the level of protection required (based on the procedure), then on breathability, and then on fit and comfort.

![Figure 5. Protective masks](image)

**Protective eyewear**

Protective eyewear is worn to protect the eyes from microorganisms as well as hard objects or debris (for example, a piece of filling material or tooth structure that, while being removed during a procedure, can fly into the clinician’s or assistant’s eye). Plastic safety glasses or eyeshields with side panels, or full coverage clear plastic shields that protect the whole face should be worn. In either case, this eyewear must be impact-resistant and lightweight for comfort. Use of a full-coverage plastic face shield has the advantage of protecting the whole face and enables the user to wear a loupe under it; however, it can limit movement, and does not replace the need for a protective face mask over the nose and mouth. If the operator uses prescription-strength eyeglasses, these should be worn under the plastic safety glasses or face shield.

![Figure 6. Protective eyewear](image)
**Gloves**

Rubber gloves were first introduced during the 1890s for use in surgery. This was followed by the availability of more tactile latex and non-latex gloves. However, the use of gloves for patient care in dentistry lagged behind for almost one hundred years. It was only after the discovery of Acquired Immune Deficiency Syndrome (AIDS) that routine gloving for patient care was recommended for dental healthcare personnel. Single-use gloves are an important element of barrier protection for patients and clinical staff. They must be used for each patient care encounter and disposed of after use with a single patient. Prior to donning gloves, personnel must always perform hand hygiene. Sterile surgical gloves must be used for surgical procedures, while nonsterile medical gloves can be used for nonsurgical procedures. Reuse and washing of gloves for patient care is an unacceptable practice since it results in loss of glove integrity and is thus inadequate for infection prevention.

When selecting gloves, considerations include materials, allergies, sizes, shapes, procedures and the manufacturer. Operatory gloves must be in the size required by the clinical staff member. In addition, it may be desirable to select gloves with right- and left-handed designs rather than ambidextrous gloves, to increase comfort and to help reduce the risk of hand and wrist strain. Ideally, gloves should be kept in a closed container or box in a closed area, to help prevent them from becoming contaminated through indirect contact with pathogens. Options for glove materials include latex, natural rubber, vinyl, nitrile and neoprene. Contact allergies and anaphylactic shock can occur in individuals sensitive to latex; contact allergies (dermatitis and contact urticaria) also can occur with natural rubber gloves and with chemicals contained in synthetic rubber gloves. If staff and/or patients have allergies to latex or natural rubber, then rubber and latex gloves must be avoided. Alternatives include nitrile, vinyl and neoprene (polychloroprene) gloves. Nitrile gloves offer superior barrier protection compared to vinyl gloves, with a lower risk of leakage (perforation) when in use. Blood transmission through nitrile gloves following simulated needlestick injuries was found to be less likely than for latex gloves. Chemical exposure also affects the integrity of gloves, with different materials being affected by different chemicals and to varying degrees; care should be taken when handling methyl methacrylate, Hibiscrub (chlorhexidine gluconate hand scrub) and other chemicals. Latex gloves offer low resistance to several chemicals. One study found neoprene gloves to be more resistant to several common healthcare chemicals. The permeability of vinyl gloves also varies with the chemical exposure. Specific information on glove characteristics and chemicals affecting glove integrity can be obtained from glove manufacturers/distributors.

If glove perforations are observed before or during patient care, gloves should be removed, hand hygiene performed and fresh gloves donned. The risk of loss of glove integrity and perforations can be reduced by wearing gloves over bare hands only (i.e., no sharp jewelry), by keeping nails short and well-trimmed, and by taking extra care during procedures involving sharp instruments or appliances. Longer procedures or procedures that require greater exposure to sharp instruments and appliances result in a higher likelihood of loss of glove integrity. While not standard practice, double-gloving has been recommended and used for surgical procedures and procedures with a high risk of glove perforation in dentistry and medicine, with inner gloves exhibiting fewer perforations.

Variation has been found in studies investigating the quality and reliability of same-material gloves. While this has become less prevalent over time, it highlights the importance of material selection and of purchasing gloves made by a reliable manufacturer. Note that medical and surgical gloves are for patient care; they are not indicated for use during instrument processing, which requires the use of heavy-duty utility gloves.

**Pre-Patient Clinical Contact Surface Care**

Clinical contact surfaces should receive barrier protection before a patient enters the operatory and must be removed and disposed of after each and every patient. Barrier protection reduces the amount of time required for cleaning and disinfecting. If barrier protection becomes compromised, when this is removed at the end of treatment the underlying surfaces must be cleaned and disinfected together with all other clinical contact surfaces.

**Barrier protection**

Barrier protection is used for headrests, operatory light handles, switches, over cables, connectors and hoses for equipment, control buttons and switches, the bracket table, the handle portion of three-in-one air/water syringes and other equipment, X-ray units, chair backs, light-curing units. It can also be used for electric handpiece motors (not the attachments).
that do not enter the patient’s mouth, and on operatory computer keyboards, which have been found to be a ready source of microorganisms (alternatively, new flat-surface keyboards are available that do not have individual keys, making cleaning and disinfecting them much easier). Washable keyboards and mouses have also been introduced.

**During Patient Care**

Patients must be provided with protective eyewear during treatment. Using a perforated closed-cassette system in the operatory results in more organized, efficient treatment as well as reduced risk of contact with contaminated instruments during transportation and instrument processing. Using containers and procedure tubs with lids also aids in reducing contamination and aids efficiency. During patient care, single-use disposable items reduce the risk of cross-infection. Available single-use items include bibs, saliva ejectors, air water syringe tips, prophylaxis handpiece attachments, handpieces, unit doses and spatulas. Using disposable single-use items is also helpful for instruments such as saliva ejectors and syringe tips that have lumens – the lumen is notoriously difficult to access and clean prior to sterilization, and residual debris hampers sterilization.

**Figure 8. Barrier protection**

**Figure 9. Disposable single-use items**

Having patients rinse with an antimicrobial mouth rinse prior to treatment has been found to reduce bacterial loads, thus reducing the load in aerosol and splatter generated during procedures.31 In addition, using a dental dam isolates the area being treated from the patient’s surrounding body fluids and tissues.32,33 Precautions that have been recommended specifically with respect to bacterial aerosols and airborne bacteria include the use of strong suction devices intraorally, extraoral vacuum aspirators, electrostatic extraction of bacteria, regular maintenance of heating and air-conditioning to reduce contamination by bacteria in the system, the use of HEPA filters, the use of ultraviolet germicidal irradiation (UVGI), and personal protection devices that are standard infection control barriers.31-37 Petroleum-based products and Vaseline should not be used on patients’ lips as this would impact glove integrity.

**After Patient Care**

After the patient’s appointment is completed, all instruments, devices and other items used for that patient’s treatment must be processed in a specific sequence and the treatment room must be prepared for the next patient. In addition, if impressions or any other laboratory-related work was performed, these must be disinfected before being sent or taken to the laboratory.

**Disposing of Sharps, Single-Use Items and Waste**

Disposal of sharps should be completed, followed by removal of contaminated instruments in trays/closed cassettes to the instrument processing area. Disposing of sharps chairside reduces the risk of needlestick injury for staff involved in instrument processing. In a space of just under 10 years, dental healthcare professionals reported 360 penetrating injuries, 87 of which were the result of needlestick injuries and more than half of which occurred following use of the sharp on a patient.38 Sharps and used glass anesthetic capsules must be placed in a sharps container that has rigid walls and a rigid base and is puncture-proof and color-coded.39 If disposable syringes were used, the needle should be left on and the whole unit placed in the sharps container. Alternatively, sharps can be placed in a device that melts and compresses sharps (Demolizer) into small solid blocks that are later disposed of. Sharps containers should be closed and replaced once they are 75% full, and must be disposed of in accordance with OSHA and local regulations and with appropriate paperwork. Single-use items that are nonhazardous can be discarded in the trash either chairside or in the instrument processing area. Examples of these would include unit doses, disposable air/water syringes, saliva ejectors and bibs. Single-use items must never be reused. Water should also be flushed through handpieces, ultrasonic scalers and air-water syringes that were used for the patient, prior to removal of environmental barriers and disinfection of contaminated clinical surfaces.

**Disposing of sharps chairside reduces the risk of needlestick injury for staff involved in instrument processing.**
The tray or cassette with all other items should then be transported to the instrument processing area, which is ideally in a separate central location and should have designated dirty and clean areas. The person disposing of single-use operatory items and transporting the contaminated trays/cassettes and instruments must first don heavy-duty utility gloves to reduce the risk of injury and subsequent contamination through broken skin. If this person was already wearing medical or surgical gloves, these should first be removed and hand hygiene performed prior to donning the utility gloves. For protection, a face mask and eye protection should also be worn when performing this task. Hazardous waste must be discarded separately, also in accordance with OSHA regulations. Cotton rolls, gauze and other materials (non-sharps) containing blood (soaked or dried on) or saliva must be disposed of in color-coded, leak-proof bags. Barrier protection should be removed, thrown in the trash and replaced, and cleaning and disinfecting of exposed clinical contact surfaces should be performed by the staff member prior to seeing the next patient. Clinical staff should remove protective eyewear and face shields, masks, and medical or surgical gloves, and should dispose of these chairside upon completion of treatment. Protective eyewear and face shields will need to be washed and disinfected before they can be reused.

The person disposing of single-use operatory items and transporting the contaminated trays/cassettes and instruments must first don heavy-duty utility gloves to reduce the risk of injury and subsequent contamination through broken skin.

Cleaning and disinfecting should be performed for:
- All clinical contact surfaces that are not covered with barrier protection
- Wherever the barrier protection was compromised.

Heavy-duty utility gloves must be worn while cleaning and disinfecting the operatory. Cleaning and disinfecting must be performed with a chemical registered for this purpose, using a standard procedure. Only EPA-registered chemical agents are acceptable for clinical contact surface disinfection; these include alcohol, hydrogen peroxide, phenolics, quaternary ammonium, citric acid and iodophor. Cleaning removes debris, and then disinfection can take place using an intermediate-level disinfectant – i.e., one that provides an effective kill against the highly resistant organism _Mycobacterium tuberculosis_ (the only organisms more resistant are bacterial spores, which would require use of a high-level disinfectant/sterilant). Cleaning and disinfecting can be performed using a one-step process (provided that heavy soiling is not present) with a product that both cleans and disinfects, or using a two-step process either with the same product or two separate products. Two-step cleaning and disinfecting is more common and is performed using a spray-wipe-spray or a wipe-throw-wipe process. For all processes, the manufacturer’s instructions must be followed and the disinfecting product must be in contact with the surface for the required length of time, and in accordance with the labeling, for disinfection to occur.

**Spray-Wipe-Spray**
With this process, the surface is sprayed first for cleaning, and then the spray and any debris are wiped away together. This is followed by the spraying of disinfectant over the surface that is allowed to air dry. The spray may be either a liquid spray, a pump spray or a foam. Separate products may be required for cleaning and disinfecting, depending on the chemical formulation.

**Wipe-Throw-Wipe**
With this process, a wipe is used to clean the surface; the wipe is then thrown in the trash and a new wipe used for disinfecting. If using a wipe, ensure that it contains a sufficient amount of the chemical agent to cover and wet the area.

For either technique, it is important to ensure that the chemical used will remain liquid on the surface long enough to achieve the kill time for _Mycobacterium tuberculosis_. Using premixed product or pre-impregnated wipes removes the need to handle and dilute chemicals. Take care to avoid overspraying from a distance to avoid aerosolization of chemicals. Wipes, sprays and foams use less volume of a chemical than liquid disinfectants do, thus reducing exposure. Other considerations when choosing a chemical agent include evidence of efficacy, kill time (for disinfectants), biocompatibility/toxicity, compatibility with operatory surfaces, whether it is single or dual-purpose, scent, ease of use, convenience and cost.

**Instrument Processing**
Once contaminated instruments, trays and cassettes have been taken to the instrument processing area, they must be sorted, cleaned, and either sterilized or treated with high-level disinfection. Instruments and other contaminated reusable items must first be sorted. Handpieces should be removed from the tray or cassette and treated separately (see below).

**Soaking Instruments**
If loose instruments or instruments in closed cassettes are cleaned immediately after being transported to the instrument processing area, no soaking is required unless debris...
Cleaning Instruments

Cleaning removes bioburden and debris to enable proper sterilization of instruments. It can be performed using an ultrasonic cleaner or an instrument washer/disinfector or by manual scrubbing. Manual scrubbing increases exposure to contaminated instruments, thus increasing the risk of injury; if manual scrubbing is essential, heavy-duty utility gloves, face or eyewear protection, and a mask must be worn, and the item must be scrubbed at arm’s length in the sink.

When an ultrasonic cleaner is used, instruments should be placed in a basket in one or two layers only, without overloading the device, and not laid directly in the base of the ultrasonic bath (this could result in areas of the instruments being inadequately cleaned). The device should be operated in accordance with the manufacturer’s instructions, with the lid closed. The ultrasonic solution is subjected to sound waves that result in cavitation (bubble formation) at low pressure and then implosion of the bubbles to clean all areas of the instruments and materials in the ultrasonic bath. If an ultrasonic bath is used, after removal from the ultrasonic bath the instruments must be rinsed to remove the ultrasonic cleaning solution, and then dried prior to further instrument processing. Ultrasonic cleaners come in a variety of sizes for different instrument load sizes and instruments. Considerations for ultrasonic cleaners include the volume/size of the device; the power level and evenness of cleaning activity, influenced by whether the sound waves are constant or intermittent (using intermittent sound waves reduces the risk of low-activity areas in the ultrasonic cleaner and therefore decreased cleaning ability); easy drainage of used ultrasonic solution (through a built-in connecting hose versus the need to tip the device on its side to empty the solution out); noise level; countertop or counter-sunk capability for the instrument processing area; and reliability. Ultrasonic cleaners are available as liquids, as enzymatic and nonenzymatic formulations for instrument processing, and as nonenzymatic effervescing soluble tablets. Enzymatic (general purpose) formulations can remove blood, organic tissue, oxides, plaster, pumice, soil, rouges and buffing compounds. Considerations for solutions include liquid/tablet formulation; whether they are enzymatic or nonenzymatic; cleaning ability; compatibility with instruments; whether they are anti-corrosive or noncorrosive; ease of use; scent and cost-effectiveness. All ultrasonic solutions should be changed at least daily – more often if the solution is in high use and/or if heavily contaminated instruments were cleaned in it.

Instrument washer/disinfectors are highly automated and will perform a “clean, rinse and dry” cycle leaving instruments ready to be inspected and immediately packaged for sterilization (provided they are visibly debris-free and undamaged). Instrument washers and washer/disinfectors reduce handling compared to ultrasonic cleaners; while washers use hot water and detergent to clean loose instruments or instruments in cassettes, instrument washer/disinfectors use high-temperature water and disinfectants. This results in the instruments being disinfected as well as cleaned and makes them safer to handle prior to actual sterilization. Considerations include whether a washer or washer/disinfector will be used, whether a countertop or built-in unit will be used, and the type of cleaning solution that will be used. The manufacturer’s instructions must be followed and compatible solutions used.
Instrument sterilization

Instruments and trays/cassettes must be sterilized after cleaning. The exact process depends on the instruments and their use. All instruments fall into one of three categories: critical, semicritical or noncritical. Critical instruments are defined as those that penetrate tissue; semicritical, as those that contact mucous membranes; and noncritical, as those that contact intact skin. All critical instruments, heat-tolerant semicritical instruments and handpieces must be heat sterilized. Although heat can affect handpieces over time, handpieces must be heat sterilized – typically in autoclaves. If the handpiece cannot be subjected to heat, it must be removed from service. Handpieces must be cleaned and prepared for sterilization in accordance with the handpiece manufacturer’s instructions and recommendations in order to avoid damage (as well as potential voiding of warranties). Heat-sensitive semicritical instruments (except handpieces) may be treated with high-level disinfectants, and noncritical instruments can be treated with high-level (or low-level) disinfectants.

Table 2. Categorization of instruments/devices and sterilization

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<tr>
<th>Category</th>
<th>Contact and penetrate tissues</th>
<th>Heat sterilization</th>
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<tbody>
<tr>
<td>Critical</td>
<td>Contact and penetrate tissues</td>
<td>Heat sterilization</td>
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<tr>
<td>Semi-critical</td>
<td>Contact mucous membranes</td>
<td>Heat-resistant</td>
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<tr>
<td></td>
<td>Do not penetrate tissues</td>
<td>Heat sterilization</td>
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<td></td>
<td>Heat-sensitive (exc. handpieces)</td>
<td>High-level disinfectant/sterilant</td>
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<td>Non-critical</td>
<td>Contact intact skin only</td>
<td>High-level disinfectant</td>
</tr>
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Critical and heat-resistant instrument packaging and sterilization

Prior to sterilization, instruments and cassettes should be packaged. Options for single-use packaging include paper pouches, plastic pouches, paper/plastic pouches, wrap, and tubing that can be sealed off at both ends. Only FDA-cleared packaging should be used, and it must be suitable for the type of sterilizer being used. The overall objectives of using sterilization packaging are to allow the sterilant (whether heat, steam or chemical vapor) to penetrate the packaging; to sterilize the contents; and to subsequently keep the contents of the packaging sterile while being stored. (Although unpackaged instruments would be sterilized, contamination would occur once the instruments are removed from the sterilizer.) Self-sealing pouches offer a quick and easy system for packaging loose instruments, handpieces and cassettes. Combination paper/plastic pouches are not recommended for use in dry-heat sterilizers as the materials may separate, compromising the packaging, nor are they recommended for sharp instruments as these may pierce the paper packaging.

Plastic or plastic/paper pouches do allow for easy identification of instruments or cassettes. Packaging must be sufficiently strong for routine instrument processing and handling without risk of tearing, and any seals must remain intact during sterilization and afterward (during storage). Note that if instruments are contained within closed cassettes, they cannot puncture packaging. Packaging must use an internal indicator – if this would not be visible without opening the packaging, then an external indicator must be used. Some newer packaging options contain built-in external and internal indicators, such as external indicators that can be peeled off after use and placed in the patient’s records, or pouches with dual external and internal multi-parameter indicators. Indicators are used to confirm that exposure to heat has occurred, and can provide information on temperature, time and exposure to steam. They do not indicate that the instruments are sterile. Packaged instruments and cassettes must be placed in the sterilizer in single layers, with no overlap or contact with other packages and without overloading the sterilizer. The most common type of sterilizer used in the United States is steam sterilization (autoclaving). Two other options are chemclaves (chemical sterilization) and dry-heat sterilization. Mechanical indicators (for measurements including cycle time and temperature reached) and the use of packaging indicators are important. Biological indicators (‘spore tests’) must also be used to check that the sterilization process was effective in killing all microorganisms – it is recommended that biological indicators be used at least weekly or every time an implantable device is used.
Sterilizers
Several types of steam sterilizers are available; all use a combination of temperature and pressure together with distilled water to generate the steam that will sterilize the instruments and cassettes. To avoid buildup of minerals inside the autoclaves and spotting on instruments and cassettes, only distilled water should be used. The pressurized steam effectively penetrates FDA-cleared sterilization packaging. The two main categories of steam sterilizer are gravity displacement autoclaves and dynamic air-removal steam sterilizers; each uses a different method by which any trapped air is removed at the start of the sterilization cycle. With gravity displacement autoclaves, the steam enters from the top and sides of the sterilizer and gravity displaces any trapped air, pushing it out through a vent in the base of the device. With dynamic air-removal sterilizers, the air is removed using a vacuum pump or electronically controlled valve. These have been found to maximize air removal and steam penetration into lumens and dental handpieces for sterilization.\(^{43}\)
Cycle length and temperature vary, depending on the type of sterilizer used and the brand, ranging from 3 to 30 minutes at 250°F to 270°F. This does not include warm-up time, depressurization or drying time. The sterilizer door must remain closed until the full cycle has been completed uninterrupted, including the drying cycle. If packaging is not dry, it should be left until completely dry before removing from the sterilizer, to avoid any risk of wicking and contamination. If packaging becomes wet or torn, the instruments must be reprocessed in fresh packaging. Steam sterilization can result in corrosion and pitting of metals over time, as well as damage to items such as O-rings due to the high temperatures used.

Dry-heat static and convection (forced air) sterilizers operate at higher temperatures than steam sterilizers do. The cycle time and temperature vary, depending on the type of dry-heat sterilizers, the brand and the instruments; these range from 6 to 120 minutes or longer and from 300°F to 375°F. Since dry heat is used, instruments are dry and no additional time is required for drying. Although the use of dry heat removes the risk of corrosion, the higher temperatures increase the risk of damage to handpieces and certain other devices. Packaging for dry-heat sterilizers should be used, since regular plastic and paper packaging used in steam sterilizers can melt or scorch in dry-heat sterilizers. Chemclaves use chemical vapor to sterilize instruments at 270°F with a cycle time of 20 minutes. As with dry-heat sterilization, the instruments are dry after the cycle. Chemclaves use a formaldehyde-alcohol-based chemical that reduces corrosion compared to steam sterilization, but increases exposure to chemicals in the office.

Determining which sterilizer and method of sterilization to use requires consideration of the number of loads, the size of loads and chamber capacity, the racks and cassette space, the space requirements and space configuration, the level of automation, and the time required for sterilization cycles.

Storage
Regardless of which heat sterilization technique is used, instruments and devices should be stored unopened in a dry storage area after sterilization.

Heat-sensitive semicritical and noncritical instruments
High-level disinfectants/sterilants are available for the sterilization of these instruments. Surface disinfectants may not be used for instrument sterilization and do not meet the EPA requirements for instrument disinfectants/sterilants. A 7.5% hydrogen peroxide solution will sterilize instruments with immersion for 6 hours (high-level disinfection in 30 minutes) and is premixed. A 3.4% buffered glutaraldehyde solution will sterilize instruments in 10 hours at 77°F (high-level disinfection in 90 minutes). There is also a 1.56% phenol solution. Soaking trays are also available for use with high-level disinfectants/sterilants. Depending on the chemical, up to 12 hours of complete immersion may be required. The manufacturer’s instructions must be followed; compatibility of the chemical with instrument materials must be known; and old, used sterilant or disinfectant must be disposed of in accordance with regulations. In addition, it is important to have proper ventilation - some chemical disinfectants/sterilants are associated with irritation of soft tissues as well as asthma. Sterilized instruments should be rinsed with sterile water, dried, segregated and stored in a dry, clean, closed container for future use to avoid contamination.

End of Day - Evacuation
At the end of each day, every clinical contact surface must be cleaned and then disinfected with an EPA-registered disinfectant, and the evacuation lines must be cleaned. This includes the high-speed suction, saliva ejector, rinse cup and cuspidor. Chemicals for evacuation lines will clean and deodorize the lines, dissolve and remove debris, and prevent buildup of calcium and other deposits. Daily use of an evacuation cleaner to keep lines clean will help maintain efficient running of the pump since it will be subjected to less strain. Conversely, if the lines are clogged, the pump must work harder with an increased risk of downtime and repairs. Using a system that incorporates the use of specially designed buckets containing the diluted evacuation solution and that has attachments for the suction lines helps to semi-automate the process. These have multiple measuring lines so that evacuation of multiple operatories can occur using one bucket load. With the additional focus on the hazards of mercury (amalgam waste) and the introduction of associated legislation, amalgam separators are being built into evacuation systems. In accordance with the manufacturers’ directions for these devices, more neutral range pH cleaners are required for use with amalgam separators. This is an important consideration when choosing the type of evacuation cleaner. It is recommended to use a cleaner designed for the soils found in evacuation systems that will not cause foaming within the system.
Summary

The infection prevention cycle involves a number of steps before during and after patient care to break the chain of infection. It must meet OSHA requirements, follow CDC recommendations and use products that are FDA cleared and EPA registered. A robust infection control procedure that follows logical, sequential steps in a well-organized manner is essential for the protection of patients and dental healthcare workers.

References

36. Osorio R, Toledo M, Liebana J, Rosales JI, Lozano JA.


www.cdc.gov/mmwr/preview/mmwrhtml/rr5217a1.htm


Questions

1. Standard Precautions apply to contact with _______.
   a. all body fluids except sweat and open wounds in skin
   b. all body fluids except sweat, mucous membranes and open wounds in skin
   c. all body fluids except saliva, mucous membranes and open wounds in skin
   d. none of the above

2. _______ must be regarded as potential sources of infectious pathogens.
   a. Patients who are perceived to be high-risk sources of infection
   b. Patients who are known to be high-risk sources of infection
   c. Patients who have signs and symptoms of infectious diseases
   d. All patients

3. The Food and Drug Administration regulates _______.
   a. high-level disinfectants/sterilants
   b. sterilization equipment
   c. sterilization packaging
   d. all of the above

4. _______ is responsible for registering intermediate-level and low-level surface cleaners and disinfectants.
   a. The FDA
   b. OSHA
   c. The EPA
   d. ANSI

5. The steps involved in infection prevention can be broken down into those that must occur _______.
   a. before a patient enters the clinical setting
   b. while the patient is being treated
   c. before the next patient is seen
   d. all of the above

6. _______ should not be used on patients’ lips.

7. _______ can be the source/reservoir for a pathogen.
   a. An inanimate object
   b. A patient
   c. A member of the operator personnel or non-operator staff
   d. all of the above

8. Disease transmission can occur through direct or indirect contact with _______.
   a. a pathogen
   b. spatter
   c. aerosols
   d. all of the above

9. Employers in healthcare settings must offer the _______ vaccination to employees.
   a. measles, mumps and rubella
   b. hepatitis B
   c. herpes zoster
   d. all of the above

10. Recommendations for hand hygiene in healthcare were issued by the CDC in _______.
    a. 2001
    b. 2002
    c. 2003
    d. 2004

11. The main goal of hand hygiene is to remove _______.
    a. all resident flora
    b. all transient flora
    c. all transient and resident flora
    d. flora that can transmit disease

12. Hand hygiene must be performed _______.
    a. prior to donning gloves
    b. after removing gloves
    c. when changing out gloves during a procedure
    d. all of the above

13. Hand hygiene must be performed following ungloved skin contact with _______.
    a. patients
    b. uncontaminated inanimate surfaces
    c. potentially contaminated inanimate surfaces
    d. a and c

14. Artificial nails _______.
    a. have never been associated with disease transmission in healthcare settings
    b. can harbor microorganisms
    c. are not recommended by the World Health Organization for healthcare personnel
    d. b and c

15. For surgical procedures, prior to donning gloves hand hygiene must be performed with _______.
    a. antimicrobial soap with persistent activity and water
    b. plain soap and water and alcohol-based hand rub with persistent activity
    c. plain soap and water or an alcohol-based hand rub
    d. a or b

16. _______ is a reason given for noncompliance with hand hygiene protocols.
    a. Skin dryness or irritation
    b. Poor sink location
    c. Lack of product availability
    d. all of the above

17. A bacterial aerosol, or bioaerosol, has been defined as existing when the particle sizes are less than _______.
    a. 20 μm
    b. 30 μm
    c. 40 μm
    d. 50 μm

18. PPE includes _______.
    a. protective clothing and masks
    b. gloves
    c. protective eyewear
    d. all of the above
19. Mask selection should be based on _______.
   a. the level of protection required
   b. breathability
   c. fit and comfort
   d. all of the above

20. If the operator uses prescription-strength eyeglasses, these should be worn _______.
   a. instead of
   b. under
   c. over
   d. none of the above

21. Nonsterile medical gloves can be used for _______.
   a. surgical procedures
   b. nonsurgical procedures
   c. instrument processing
   d. all of the above

22. The risk of loss of glove integrity and perforations can be reduced by _______.
   a. not wearing sharp hand jewelry under them
   b. keeping nails short and well-trimmed
   c. taking care during procedures involving sharp instruments
   d. all of the above

23. Using a perforated closed-cassette system in the operatory results in _______.
   a. more organized, efficient treatment
   b. reduced risk of contact with contaminated instruments during transportation
   c. reduced risk of contact with contaminated instruments during instrument processing
   d. all of the above

24. Available single-use items include _______.
   a. saliva ejectors
   b. prophylaxis handpiece attachments
   c. air water syringe tips
   d. all of the above

25. Having patients rinse with an antimicrobial mouth rinse prior to treatment has been found to _______.
   a. have no effect on
   b. reduce
   c. increase
   d. none of the above

26. Precautions that have been recommended with respect to bacterial aerosols and airborne bacteria include _______.
   a. the use of strong suction devices intraorally
   b. the use of HEPA filters
   c. regular maintenance of heating and air-conditioning
   d. all of the above

27. Disposing of sharps chairside _______.
   a. is not recommended
   b. reduces the risk of needlestick injury
   c. increases the risk of needlestick injury
   d. none of the above

28. _______ must be placed in a sharps container that has rigid walls and a rigid base and is puncture proof and color-coded.
   a. Sharps
   b. Dappens dishes
   c. Glass anesthetic capsules
   d. a and c

29. If disposable syringes were used, the needle _______ prior to disposal in a sharps container.

30. Sharps containers should be closed and replaced once they are _______ full, and must be disposed of in accordance with regulations.
   a. 65%; EPA and local
   b. 70%; EPA and OSHA
   c. 75%; OSHA and local
   d. 80%; EPA and local

31. The person disposing of single-use operatory items and transporting the contaminated trays/cassettes and instruments must first do _______.
   a. nonsterile medical gloves
   b. surgical gloves
   c. heavy duty utility gloves
   d. any of the above

32. Materials (non-sharps) containing blood (soaked or dried on) or saliva must be disposed of _______.
   a. in household trash containers
   b. in leak-proof pouches
   c. in leak-proof, color-coded bags
   d. along with the sharps

33. Only _______ chemical agents are acceptable for clinical contact surface disinfection.
   a. EPA-registered
   b. OSHA-registered
   c. ISO-registered
   d. ANSI-registered

34. Depending on the product(s) used, cleaning and disinfecting can be performed using a _______.
   a. one-step process
   b. two-step spray-wipe-spray process
   c. two-step wipe-throw-wipe process
   d. all of the above

35. It is important to ensure that a surface disinfectant will remain liquid on the surface long enough to achieve the kill time for _______.
   a. Mycobacterium tuberculosis
   b. Herpes zoster
   c. Streptococcal bacteria
   d. none of the above

36. If instruments will be held for a time prior to processing, soaking them in a presoak or using an enzymatic spray _______.
   a. prevents debris from drying on the instruments
   b. makes subsequent cleaning easier
   c. makes little difference
   d. a and b

37. Multipurpose enzymatic liquid solutions are available that can be used _______.
   a. as presoaks
   b. as ultrasonic cleaners and as solutions in instrument washer/disinfector
   c. as solutions in instrument washer/disinfector
   d. all of the above

38. Ultrasonic cleaners are available as _______.
   a. liquids
   b. enzymatic and nonenzymatic formulations for instrument processing
   c. nonenzymatic effervescing soluble tablets
   d. all of the above

39. All ultrasonic solutions should be changed _______.
   a. at least daily
   b. at least weekly
   c. at least biweekly
   d. at least monthly

40. Instrument washer/disinfectors _______.
   a. are highly automated
   b. reduce handling
   c. make instruments safer to handle prior to actual sterilization
   d. all of the above

41. Critical instruments are defined as those that _______.
   a. penetrate tissue
   b. contact intact skin
   c. contact mucous membranes
   d. all of the above

42. All _______ must be heat sterilized.
   a. handpieces
   b. critical instruments
   c. heat-tolerant semicritical instruments
   d. all of the above

43. Heat-sensitive semicritical instruments (except handpieces) may be treated with _______.
   a. low-level disinfectants
   b. intermediate-level disinfectants
   c. high-level disinfectants
   d. b and c

44. The overall objective of using sterilization packaging is to _______.
   a. allow the sterilant to penetrate the packaging
   b. sterilize the contents
   c. keep the contents of the packaging sterile while being stored
   d. all of the above

45. Some newer packaging options _______.
   a. contain built-in external and internal indicators
   b. include pouches with dual external and internal multiparameter indicators
   c. have an external indicator that can be peeled off and placed in the patient’s records
   d. all of the above

46. It is recommended that biological indicators be used for _______.
   a. at least weekly
   b. at least daily
   c. every time an implantable device is used
   d. a and c

47. Surface disinfectants _______.
   a. may not be used for instrument sterilization
   b. may be used for low-grade instrument sterilization
   c. may be used for noncritical instruments
   d. none of the above

48. A 7.5% hydrogen peroxide solution will sterilize instruments with immersion for _______.
   a. 4 hours
   b. 6 hours
   c. 8 hours
   d. 10 hours

49. At the end of each day, _______.
   a. every clinical contact surface must be cleaned and then disinfected
   b. the evacuation lines must be cleaned
   c. patients must be booked for the following day
   d. a and b

50. The infection prevention cycle must _______.
   a. meet OSHA requirements
   b. follow CDC recommendations
   c. use products that are FDA cleared and EPA registered
   d. all of the above
Circling In On Infection Prevention

Educational Objectives
1. List and describe the overall steps involved in infection control in the dental office and their sequencing for patient care.
2. List and describe appropriate personal protective equipment (PPE) as well as other steps clinical and administrative staff can take to protect themselves.
3. Describe the treatment of clinical contact surfaces.
4. Describe the workflow and processing of instruments.
5. List and describe the procedures that must be performed at the end of each day.

Course Evaluation
Please evaluate this course by responding to the following statements, using a scale of Excellent = 5 to Poor = 0.

1. Were the individual course objectives met?  
   Objective #1: Yes No  
   Objective #2: Yes No  
   Objective #3: Yes No  
   Objective #4: Yes No  
   Objective #5: Yes No

2. To what extent were the course objectives accomplished overall?  
   5 4 3 2 1 0

3. Please rate your personal mastery of the course objectives.  
   5 4 3 2 1 0

4. How would you rate the objectives and educational methods?  
   5 4 3 2 1 0

5. How do you rate the author's grasp of the topic?  
   5 4 3 2 1 0

6. Please rate the instructor's effectiveness.  
   5 4 3 2 1 0

7. Was the overall administration of the course effective?  
   5 4 3 2 1 0

8. Do you feel that the references were adequate?  
   Yes No

9. Would you participate in a similar program on a different topic?  
   Yes No

10. If any of the continuing education questions were unclear or ambiguous, please list them.  

11. Was there any subject matter you found confusing? Please describe.  

12. What additional continuing dental education topics would you like to see?  

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