Section 3 General Concepts in Infection Control

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General Concepts in Infection Control

The Centers for Disease Control offers an extensive glossary pertinent to Infection Control in the Dental Setting at the following address:

http://www.cdc.gov/OralHealth/infectioncontrol/glossary.htm

Paths to Exposure to Microorganisms

There are 4 main ways that a dental healthcare worker (DHCW) can be exposed to microorganisms:

1. Direct contact with blood, body fluids or other patient materials
2. Indirect contact with blood via contaminated objects (e.g. instruments or environmental surfaces)
3. Contact of conjunctiva, nasal or oral mucosa with droplets (e.g. splatter) containing microorganisms generated from an infected person and propelled a short distance (e.g. by coughing, sneezing or talking).
4. Inhalation of airborne microorganisms that can remain suspended in the air for long periods.

Infection through any of these routes requires that all of the following conditions be present:

1. A pathogenic organism of sufficient virulence and adequate numbers to cause disease
2. A reservoir or source that allows the pathogen to survive and multiply (e.g. blood)
3. A mode of transmission from the source to the host
4. A susceptible host
5. A portal of entry through which the pathogen can enter the host
   • Penetration of skin with a sharp contaminated object;
   • Broken skin or mucosa that allows splatter of contaminated material to enter;
   • Transfer of contaminated material from environmental surfaces into airway;
   • Aerosol inhalation (e.g. common cold, TB).

Surface Categories

Environmental surfaces can be divided into clinical contact surfaces and housekeeping surfaces. Because housekeeping surfaces (e.g., floors, walls, and sinks) have limited risk of disease transmission, they can be decontaminated with less rigorous methods than those
used on dental patient-care items and clinical contact surfaces. Strategies for cleaning and disinfecting surfaces in patient-care areas should consider the 1) potential for direct patient contact; 2) degree and frequency of hand contact; and 3) potential contamination of the surface with body substances or environmental sources of microorganisms (e.g., soil, dust, or water).

**Definition of Operatory Areas**

Establishing defined areas in the operatory for placement of instruments, items, and material prevents cross-contamination by controlling the movement of these materials during dental procedures. These areas are categorized depending on their clinical contact or non-contaminated status. There are 5 designated work areas in the operatory, indicated in the following diagram:
Clinical Contact Surfaces

AREA 1. The bracket table
   For items that are used frequently in the procedure and which come into direct contact with mucous membranes and/or body fluids.

AREA 2. The top of the instrument cabinet/rolling cart
   For items which are infrequently used in the procedure but will be contaminated (e.g. the syringe, rubber dam equipment, burs, impression trays, etc.).

AREA 3. The countertop adjacent to the sink
   For preparing and dispensing cements, impression materials, etc.; and for patients' models, dies, and registrations; water baths; etc. These items will eventually become contaminated. Apparatus which cannot be disinfected properly (fiber optic light source, ultrasonic unit, etc.) must be protected with a barrier (bag, plastic film, etc.).

Non-Contaminated Areas:

AREA 4. The remaining area of the countertop
   This is where the computer is located since it can not be sterilized or disinfected. The computer keyboard and mouse must not be touched without the use of a barrier. This is where the dental chart should also be located. This is a housekeeping surface.

AREA 5. The top of the operatory cabinets
   This is where supplies such as the yellow supply bins are kept during the patient visit, once all the supplies needed for the visit are removed.

Items not involved in the proposed patient treatment must not be visible at the unit.
Sterilization

Sterilization is the use of a physical or chemical procedure to destroy all microorganisms including substantial numbers of resistant bacterial spores. This can be achieved by a variety of methods including moist heat, dry heat, chemicals,

Types of Sterilization

There are two methods used for sterilizing objects in the College of Dentistry: moist heat (autoclaving); and dry heat. Autoclaving (the use of moist heat under pressure) is the most common method of sterilization in our clinics. Not all items or materials can or should be autoclaved. For example, sharp instruments tend to dull more quickly after repeated autoclaving compared with dry heat sterilization.

Operation of Sterilizers

Moist Heat (Autoclaving)

Autoclaving occurs when the following conditions are met:

- Sterilizer temperature is set to 121°C (250°F).

  Higher temperatures with shorter times are only appropriate for unbagged instruments—a situation generally not encountered in the College of Dentistry.

- Sterilizer time is set for a minimum of 30 minutes.

- Sterilizer pressure is set for a minimum of 15 psi.

The cycle of any steam sterilizer is not complete until the instrument bags are dry! Damp instrument bags allow bacteria and other germs to penetrate the paper and contaminate the instruments inside. This drying must take place in an environment that prevents their contamination.

Large Automatic

The cycle for bagged or closed containers must be used. These sterilizers may appropriately be used for all bagged instruments.

Small Automatic (Statim®)

These autoclaves should have the appropriate cycle chosen. If there is no active drying portion of the cycle, do not expose the instruments immediately at the end of the cycle but instead, remove the cassette from the autoclave and allow it to cool to room temperature before opening. In all cases, follow the manufacturer’s directions.
Small Manual
See manufacturer’s directions for proper operation. In small manual steam autoclaves in which there is no provision for the active drying of the contents after sterilization, immediately after the pressure has dropped to zero, open the door about ¼ inch and wait approximately 15 minutes before removing the bagged instruments. Adjust this dry time until an adequate drying period is found. Whether there is an active drying cycle or not, instrument bags in the center of the load should not be damp. **Instrument bags must be dry when removed from the autoclave!**

The door must be opened immediately because the only heat for drying is that of the instruments and that of the chamber itself. If there is a delay in opening the chamber following the sterilization cycle, the chamber and instruments will cool and there may be no drying. If instrument bags are moist when removed from the autoclave and handled or placed on a surface, the microorganisms on the hands or the surface will be “wicked” into the inner surface of the bag where they will contaminate the instruments.

Dry Heat
Dry heat sterilization, or “oven sterilization” must be used for some burs and orthodontic instruments.

Instruments for oven sterilization should be prepared in the same way as for autoclaving. They must be completely dry before packaging and placing into the oven.

Dry heat sterilizers should be set to a temperature of 170°C (340°F) and allowed to come up to that temperature before placing packages inside.

Each dry heat sterilizer must have a thermometer so that accurate temperature may be ascertained.

Packages must be treated for a full 2 hours without opening the door during the cycle. If the door is opened in mid-cycle then the timing must begin again.

*When the door is opened, the temperature of the contents goes down and, while it probably remains warm in the center of the load, it will take an unknown length of time to heat the center up to where it was. So, the only sure thing is to begin the timing all over again.*
Chemical Sterilization

Chemicals may be used to sterilize only those items that cannot be sterilized by autoclaving or dry heat. The chemical agent used is glutaraldehyde, usually formulated in a 2% solution, and it is used full strength.

Since Glutaraldehyde vapors are toxic and can cause blindness and skin sensitivity, the following precautions must be followed:
- The container used must have a self-sealing lid
- The container must have a basket to avoid splashing.
- Avoid prolonged breathing of the vapor.

Instrument Processing

1. Put on a pair of heavy-duty, nitrile rubber gloves and protective eyewear.
2. Clean and dry all instruments to be sterilized.
3. Immerse them for at least 10 hours in the full-strength glutaraldehyde solution. It is important to use the basket to immerse items in order to avoid hazardous splatter that occurs when items are dropped into the solution. Every time that an item is added to the solution, the solution and everything in it become contaminated. Therefore, the timing begins when the last item is added to the solution.
4. Wash the item(s) free of the glutaraldehyde, using sufficient water, and dry.
   - If an item is to be kept in a sterile state, it must be held with a sterile forceps or other suitable holder and the washing must be done with sterile water. Drying must be done in a manner that does not contaminate the instrument(s) which must then be placed into a closed, sterile container.

Glutaraldehyde solutions have a certain useful life which varies with their chemical makeup (chemical formula and brand) and is dependent on the bioburden present on the instruments immersed in it. It is difficult to determine whether a solution, used or unused, is still active. Therefore, these solutions must be discarded on a regular basis (weekly).

Most equipment currently produced for use in dental settings is able to be autoclaved. Chemical sterilization is potentially hazardous and unreliable and should only be used as a last resort.
Instrument Processing for Autoclave and Oven Sterilization

- Handle sharp instruments to be autoclaved, wearing a pair of heavy-duty, nitrile rubber gloves.

- Thoroughly clean and dry the items.

- Items in cassettes should be placed into a sterilization pouch so that the name and barcode of the item is visible through the clear side of the pouch. A chemical process indicator that changes color when heated must be placed inside the pouch. If the pouch does not have a built in chemical process indicator (changes color when heated), affix a piece of sterilization indicator tape on the outside as a second indicator.

- Any item to be sterilized singly is placed into a sterilization pouch. A chemical process indicator that changes color when heated must be placed inside the pouch. If the pouch does not have a built in chemical process indicator (changes color when heated), affix a piece of sterilization indicator tape on the outside as a second indicator.

- Place packages vertically in the sterilizer rather than stacking them on top of each other.

- Do not overload the sterilizer. The steam or hot air must be able to flow freely around each object.

- If instrument cassettes are used, the lids should fit loosely to allow the steam to circulate inside the cassette. Cassettes must be designed with holes for air circulation.

*Instruments of carbon steel or low quality stainless steel are prone to rusting when processed routinely in an autoclave. It is recommended that instruments be coated with 2% sodium nitrite (Proclave® protective emulsion) after washing and drying and before moist heat sterilization.*

Monitoring Procedures

The proper functioning of all sterilizers is to be checked with mechanical indicators (time, temperature and pressure gauges) and biological indicators (spore tests). Records of all mechanical and biological indicator tests must be maintained.

Biological indicator tests are recommended at the following times:

- At least weekly
Any time an implantable device is being sterilized. The device should not be used until the results of the biological indicator test have been received.

The following is to be carried out by those responsible for operating the sterilizers:

- On Friday morning, pick up the red box containing the necessary spore strip envelope(s) from the baskets attached to the outside of the Microbiology Laboratory door (room 522-1). The boxes will be labeled as to the clinic or area to be checked. The envelopes will be labeled as to the sterilizer to be checked.
- Place the spore strip envelope inside a bag, pack, or cassette. Place this package in the center of a normal load in a normal sterilizer cycle.
- Upon completion of the cycle, remove the spore strip envelope and return it to the red box.
- Return the red box, before 4:30 p.m. Friday, to one of the baskets attached to the Microbiology Laboratory door.
- Respond appropriately if informed that the sterilizer failed the spore test.

Processing of each spore strip is carried out in the microbiology laboratory according to the following protocol.

- Each strip is aseptically removed from its envelope, dropped into a tube of Tryptic Soy Broth, and incubated at the appropriate temperature (37°C for steam sterilizers and 56°C for dry heat sterilizers) for 1 week.
- Tubes will be examined for growth on the following Monday and each day thereafter.
- For any tubes showing growth, after ruling out false positives, the appropriate sterilizer operator will be immediately informed of the situation and the cause of the failure determined and corrected if possible.
- Records of results of all tests will be kept by the Microbiology Laboratory and a note with the individual sterilizer results will be included in the red box the following Friday. **If there is a positive test result the department will be informed immediately.**

**Positive Biological Indicator Test Results**

1. Remove the sterilizer from service and review sterilization procedures (e.g., work practices and use of mechanical and chemical indicators) to determine whether operator error could be responsible.
2. Retest the sterilizer by using biological, mechanical, and chemical indicators after correcting any identified procedural problems.
3. If the repeat spore test is negative, and mechanical and chemical indicators are within normal limits, put the sterilizer back in service.
   • Do not use the sterilizer until it has been inspected or repaired or the exact reason for the positive test has been determined.
   • Recall, to the extent possible, and reprocess all items processed since the last negative spore test.
   • Before placing the sterilizer back in service, rechallenge the sterilizer with biological indicator tests in three consecutive empty chamber sterilization cycles after the cause of the sterilizer failure has been determined and corrected.

NOTE: CONTACT MAINTENANCE IMMEDIATELY FOR ANY UNEXPLAINED STERILIZER MALFUNCTION

Disinfection
Disinfection is the inactivation of pathogenic microorganisms but not all microorganisms and not all spores.

Levels of Disinfection
Three levels of disinfection have been differentiated, depending upon the type and form of microorganisms destroyed.

High-level disinfection is a process that can kill some, but not necessarily all, bacterial spores. It is also tuberculocidal.

Intermediate-level disinfection is a process that kills *Mycobacterium tuberculosis* var. *bovis* but may not be capable of killing bacterial spores. Intermediate-level disinfection will also kill the Hepatitis B Virus (HBV) and the Human Immunodeficiency Virus (HIV).

Low-level disinfection is the process that kills most bacteria, some fungi, and some viruses. It does not kill bacterial spores or *Mycobacterium tuberculosis* var. *bovis*.

Disinfecting Agents
Disinfectants are regulated by the EPA. By law, users must follow the manufacturer’s directions of use, or assume liability for injuries resulting from off-label use. The following are used at the College of Dentistry clinics:
Glutaraldehyde
The brand of glutaraldehyde presently used in the College is Sterall®. When used full strength, Sterall® can sterilize items immersed in it for 10 hours. It can be used as an immersion disinfectant when used full strength or diluted 1:10 with water (1 part glutaraldehyde and 9 parts water).

Glutaraldehyde solutions should be discarded monthly.

| Glutaraldehyde solutions have a certain useful life which varies with their chemical makeup (brand) and the number of instruments that have been immersed in them (extent of bioburden). It is thus difficult determining whether a solution, used or unused, is still active. Therefore, these solutions must be discarded on a regular basis. |

Cavicide
Cavicide is an intermediate-level surface disinfectant with Isopropanol and Ethylene Glycol Monobutyl Ether as active ingredients. The stock Cavicide comes ready to use and has a shelf life of two years. For Cavicide to be fully effective, surfaces must be exposed to the agent for the recommended amount of time, according to the manufacturer’s instructions. Refer to Section 6 of this manual for dental operatory disinfecting procedures using Cavicide.

The following table depicts the effectiveness of Cavicide when used as recommended.

<table>
<thead>
<tr>
<th>Exposure Time</th>
<th>Pathogens Killed</th>
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| 3 minutes     | • Mycobacterium tuberculosis var: bovis (BCG)  
• Staphylococcus aureus  
• Pseudomonas aeruginosa  
• Salmonella enterica  
• Trichophyton mentagrophytes |
| 2 minutes     | • Methicillin Resistant Staphylococcus aureus (MRSA)  
• Vancomycin Resistant Enterococcus faecalis (VRE)  
• Staphylococcus aureus with reduced susceptibility to vancomycin  
• Hepatitis B Virus (HBV)  
• Hepatitis C Virus (HCV)  
• Herpes Simplex Virus Types 1 and 2  
• Human Immunodeficiency Virus (HIV-1)  
• Human Coronavirus (not associated with Severe Acute Respiratory Syndrome or SARS) |
• Influenza A2 Virus

**Sodium Hypochlorite (bleach)**
Sodium hypochlorite is used at a 1:10 dilution (1 part bleach and 9 parts water). Hypochlorite solutions should be discarded at the end of each day. These solutions should be used only once and never reused.

*Diluted sodium hypochlorite has a short period of activity. It is rapidly inactivated by any bioburden and should therefore only be used once.*

**Ultrasonic Cleaners**
These devices use waves of high-frequency acoustic energy (a process known as "cavitation") into a container filled with a cleaning solution to break up debris on instruments and appliances.

**Instrument Processing:**
- Always wear nitrile rubber gloves and protective eyewear.
- Pre-rinse all instruments.
- Use only a cleaning solution manufactured for use in ultrasonic cleaners.
- If dirty instruments will be placed into a plastic bag for cleaning, first place the washed instruments into the bag, making sure that the bag is not damaged in the process. Then fill the bag with enough cleaning solution to completely cover the instruments. Remove almost all the air from the bag and close with the zip-lock closure.
- Make sure instruments are completely immersed.
- Keep instruments the proper distance from the bottom of the tank.
- Keep the solution 1½ inches below the top of the tank.
- Operate the unit only with a well-fitting cover in place.
- Clean instruments for an adequate amount of time. This will vary depending on the amount of soiling and whether debris has dried on surfaces. Hinged instruments also will take longer. Follow the manufacturer’s recommendations when using a thermal disinfector.
Unit Maintenance procedures
Change the cleaning solution daily.

- Disinfect the unit tank and dry it at the end of the workday.
- Test the unit for cleaning efficiency at least once a month as follows:
  1. Cut a piece of lightweight aluminum foil about 1 inch shorter than the length of the chamber and 1 inch longer than the depth of the solution in the chamber.
  2. Insert the foil vertically into the filled chamber with the length of the foil running the length of the chamber and the bottom of the foil about 1 inch above the bottom of the chamber. Do not let the foil touch the bottom of the tank.
  3. Run the unit for 20 seconds.
  4. Inspect the immersed portion of the foil for small, uniformly spaced indentations.
     - Uniform pitting or indentations indicate the unit is functioning properly.
     - One or more smooth areas surrounded by indentations indicate irregular or sporadic cleaning and that the unit needs to be serviced.

Thermal Disinfectors
Thermal disinfectors are an automatic cleaning device which uses hot water and chemical cleaners.

Instrument Processing
- The instruments are loaded into the thermal disinfector. Do not pack instruments tightly or the water jets will not be able to reach all instrument surfaces.
The thermal disinfector is set to automatically go through a rinse cycle with heated water and then a disinfecting cycle, where it automatically releases the chemical disinfectant.

Follow manufacturer’s recommendations when using a thermal disinfector.