

CDC 4Y051N

Dental Assistant Journeyman

Volume 1. Dental Infection Control, and Radiology



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CDC 4Y051N contains one volume, which primarily includes the subject knowledge requirements for your upgrade training.

Volume 1, *Dental Infection Control and Radiology*, is divided into three units: Unit 1 presents information about the infection control program and Occupational Safety & Health Administration (OSHA) standards. Unit 2 discusses the principles of sterilization along with clinical, radiology, and laboratory procedures for infection control. Unit 3 will provide information on the principles of radiology, the paralleling techniques, film processing and mounting, and the evaluation of radiographs.

A glossary of terms and abbreviations and acronyms is included at the end of this volume.

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NOTE:

In this volume, the subject matter is divided into self-contained units. A unit menu begins each unit, identifying the lesson headings and numbers. After reading the unit menu page and unit introduction, study the section, answer the self-test questions, and compare your answers with those given at the end of the unit. Then do the unit review exercises.

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Unit 1. Infection Control 1: Program and OSHA Standards, Transmission and Prevention, and Cleaning and Disinfection

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TODAY AGENCIES OF Occupational Safety and Health Administration (OSHA), Food and Drug Administration (FDA), Environmental Protection Agency (EPA), Centers for Disease Control (CDC), and the American Dental Association (ADA), impact the infection control guidelines and recommendations that the Air Force Dental Service follows. Infection control standards in dentistry are in a continuous state of change while seeking to provide greater protection to everyone concerned—whether directly or indirectly involved with dental treatment. In this unit we’ll look at three main areas concerning infection control: infection control and OSHA standards, transmission and prevention, and cleaning and disinfection procedures. Unit 2 will cover additional procedures.

1–1. Infection Control and OSHA Standards

You may be skeptical about the need for strict standards of infection control in dentistry. Dental treatment may seem harmless in comparison with the aseptic concerns of the medical-surgical area. However, the oral cavity supports one of the most concentrated microbial populations of the body. Dental personnel are in constant contact with mucous membranes, saliva, blood, and other body fluids that may be infectious. The potential for infection of the dental team, coworkers, and patients is extremely high. Direct and indirect exposure to pathogenic (disease-producing) organisms occurs nearly every minute of the workday.

1. The infection control program

The objective of infection control is total or partial destruction of the many hundreds of microorganisms known to be pathological or possess pathological potential to produce disease. Every dental patient may harbor microorganisms potentially dangerous to themselves and others. Principles of infection control, adequately applied in the dental clinic, protect patients the dental health team, you, your friends, and family from cross-contamination.

USAF Dental Service Infection Control Program

The goals of the USAF Dental Service Infection Control Program are to protect the health of all patients and employees and to comply with applicable federal, state and local regulations governing infection control, job safety, and management of regulated medical waste.

At the direction of Headquarter United States Air Force/Surgeon General (HQ USAF/SG), the Dental Evaluation and Consultation Service (DECS) periodically issues updated guidelines. These guidelines reflect current standards for dental infection control. They are designed to comply with current federal regulations including those issued by OSHA and EPA. The most current federal, state, local (including host country), and Air Force instructions take precedence over these guidelines whenever they are more stringent.

Guidelines and recommendations issued by nonregulatory agencies including the Joint Commission for Accreditation of Healthcare Organizations (JCAHO), CDC, and ADA are used as references in the development of dental service infection control and employee protection programs.

The guidelines for the USAF Dental Infection Control Program are coordinated with the medical treatment facility (MTF) infection control committee by the dental commander and dental infection control officer (ICO) in order to determine local dental operating instructions.

Each dental clinic maintains a Dental Infection Control Program Notebook that contains, at a minimum, the following items:

- AFI 44-108, *Infection Control Program*.
- CFR Part 1910.1030 Subpart Z [Amended]—OSHA Occupational Exposure to Bloodborne Pathogens; Final Rule or successor.
- Current USAF Dental Infection Control Program, policy letters, and dental infection control consultant's updates.
- Installation and/or MTF instructions on infection control, occupational exposure to blood-borne pathogens, and management of regulated medical waste.
- References including current OSHA, CDC, and ADA guidelines for infection control in dentistry.

The Special Consultant for Dental Infection Control prepares a list of recommended references and updates it as needed.

Special Consultant for Infection Control

The USAF Assistant Surgeon General for Dental Services appoints a Special Consultant for Infection Control. This special consultant advises HQ USAF/SG on current issues relevant to dental infection control and occupational exposure to infectious disease. The special consultant also acts as a liaison with USAF consultants in related areas, including dental specialties, infection control, infectious disease, operating room nursing, and public health (PH). The consultant is also responsible for opening and maintaining lines of communication with federal regulatory and advisory agencies, including OSHA and CDC, as well as with other recognized authorities in the fields of dental infection control and occupational safety.

The Special Consultant for Infection Control develops and publishes HQ USAF/SG-approved guidelines for the USAF Dental Infection Control Program. This guidance is updated, as needed, based on changes in federal regulations, recommendations from advisory agencies, and current Air Force policy.

The individual appointed to this position also assists base dental services in developing effective programs by disseminating information via periodic infection control updates, as well as direct and written communication.

Dental infection control officer

The Dental Squadron Commander (DSC) assumes overall responsibility for overseeing the dental service infection control and occupational safety programs within the base dental service. The DSC appoints a dental infection control officer (ICO) who develops and implements the base dental service infection control program. The program includes measures to comply with current USAF policy and guidelines, as well as OSHA requirements for protection of health care personnel (HCP) from

exposure to blood-borne pathogens. The dental ICO also represents the dental service on the MTF infection control committee. The individual appointed to this position is responsible for ensuring that initial, annual, and update training for dental personnel on dental infection control and occupational exposure to blood-borne pathogens is in accordance with OSHA standards.

Program surveillance

A successful infection control and employee protection program must have valid means to measure its effectiveness. Methods recommended for this purpose include clinic-acquired infection reporting, sterilization monitoring, and scheduled and unscheduled inspections.

Surveillance Methods	Description
Health-care associated infection (HCI) reporting	Used to assess the effectiveness of the dental infection control program. HCIs are defined as those infections which were not present or incubating at the time the patient was treated
Sterilizer-monitoring	This program must be implemented. The results of sterilizer testing must be documented and reported to the MTF infection control committee.
Inspections	Dental infection control personnel conduct and document routine scheduled and unscheduled inspections of dental treatment rooms, the dental laboratory, dental radiology, decontamination and sterilization areas, and locations where sterile items are stored.

2. Occupational exposure to blood-borne pathogen

Occupational exposure is reasonably anticipated skin, mucosal, eye, or parenteral contact with blood or other potentially infectious materials (OPIM), including saliva. The *OSHA Bloodborne Pathogens Standard* is a comprehensive federal rule that sets forth specific requirements for preventing the transmission of blood-borne diseases to employees.

Transmission of Acquired Immune Deficiency Syndrome (AIDS) prompted the regulatory action; however, OSHA is also concerned about hepatitis B and other blood-borne diseases. Blood-borne pathogens are defined as pathogenic microorganisms that are present in human blood and can cause disease in humans. The federal standard created major changes within the realm of infection control in dentistry—former recommendations are now mandatory requirements that must be complied with.

Compliance

As of 6 July 1992, all USAF dental services began compliance with these guidelines:

- 29 CFR Part 1910.1030, OSHA Occupational Exposure to Bloodborne Pathogens, Final Rule.
- OSHA 3129, Controlling Occupational Exposure to Bloodborne Pathogens in Dentistry.

These OSHA requirements are intended to protect HCPs from occupational exposure to blood-borne pathogens, including human immunodeficiency virus (HIV) and hepatitis B virus.

Risks

OSHA determined that dental personnel face a significant health risk as a result of occupational exposure to blood and other potentially infectious materials because they may contain blood-borne pathogens. This risk can be minimized or eliminated by using a combination of engineering and work practice controls, personal protective equipment (PPE), training, surveillance, hepatitis B vaccination (HBV), signs and labels, and other provisions. Standard precautions form the basis for the employee protection program for dental service personnel.

Exposure control plan

OSHA requires all MTFs have a written exposure control plan that identifies all employees subject to occupational exposure, the procedure for evaluating exposure incidents, and the schedule for implementing the provisions of the rule. This document must be accessible to all employees, available to OSHA, and reviewed and updated at least annually.

Dental services are not required to prepare a separate, comprehensive, exposure control plan, if they are covered under an MTF or installation plan. Dental service specific procedures for protecting employees from occupational exposure to blood-borne pathogens should be incorporated into dental infection control or occupational safety operating instructions when the dental service is covered by an installation or MTF plan.

The dental ICO conducts an occupational exposure determination in accordance with current OSHA guidelines. This includes a determination of the risk for actual or potential exposure to blood or OPIM in duty performance. Identification of all individuals who work in areas where there is reasonably anticipated exposure to blood or OPIM must also be included. The exposure determination must be based on the definition of occupational exposure without regard to the use of personal protective clothing and equipment.

The responsibility for providing HBV vaccination, post-exposure evaluation and follow up, and management of regulated medical waste is usually invested with other MTF functions such as PH and bioenvironmental engineering (BEE). The dental ICO must ensure proper coordination with these functions.

Training

The dental ICO must develop a training program in accordance with current OSHA guidelines for controlling occupational exposure to blood-borne pathogens in dentistry. Training sessions must be comprehensive in nature, appropriate for the educational level, literacy, and language of personnel, and provide the opportunity for interactive questions and answers.

According to the OSHA Standard, the training program must, *as a minimum*, specifically include the following:

- An accessible copy of the regulatory text of the standard and an explanation of its content.
- An explanation of the epidemiology and symptoms of blood-borne diseases.
- An explanation of the modes of transmission of blood-borne pathogens.
- An explanation of the written exposure control plan and how to obtain a copy.
- How to recognize occupational exposure.
- The methods to control occupational transmission of blood-borne pathogens.
- How to select, use, remove, handle, decontaminate, and dispose of personal protective clothing and equipment.
- Information on the hepatitis B vaccine and vaccination, the availability of the vaccine, and whether vaccination is available at no cost to the personnel.
- Information on emergencies involving blood and other potentially infectious materials.
- An explanation of the reporting mechanisms for exposure incidents.
- Information on the post-exposure evaluation and follow-up available by a health care professional when an exposure incident occurs.
- An explanation of labels, signs, and other markings for contaminated materials, such as instruments and laundry.
- A question and answer session on any aspect of the training.

Exposure incidents

An exposure incident is a specific eye, mouth, other mucous membrane, non-intact skin, or parenteral contact with blood or other potentially infectious material that results from the performance of an employee's duties. An example of an exposure incident is a puncture from a contaminated sharp instrument.

Thorough assessment and confidentiality are critical issues when evaluating exposure incidents. Personnel should immediately report exposure incidents to initiate a timely follow-up process by a health care professional. Such a report initiates the procedure for a prompt evaluation of the source individual's status.

Personnel who have had an exposure incident must be directed to a health care professional. The employer must provide the health care professional with the following:

- A copy of the blood-borne pathogens standard.
- Descriptions of the employee's job duties as they relate to the incident.
- A report of the specific exposure incident (accident report), including routes of exposure.
- The results of the source individual's blood tests, if available.
- Relevant employee medical records, including the vaccination status.

At this time, a baseline blood test to establish the employee's HIV and HBV status is drawn, if the employee consents. The source individual is any patient whose blood or body fluids are the source of an exposure incident to the employee. Testing the source individual's blood cannot be done in most states without written consent. The results of the source individual's blood tests are confidential and should be directed only to the attending healthcare professional.

As soon as possible, test results of the source individual's blood must be made available to the exposed employee through consultation with the health care professional.

Following the post-exposure evaluation, the health care professional provides a written opinion to the employer. This opinion is limited to a statement that the employee has been informed of the results of the evaluation and told of the need, if any, for further evaluation or treatment. All other findings are confidential. The employer must provide a copy of the written opinion to the employee within 15 days of the evaluation.

Recordkeeping

Two types of employee-related records are required by the blood-borne pathogens standard: medical and training.

Medical records

A medical record is established for each employee with occupational exposure. This record is confidential and separate from other personnel records. This record may be kept on-site or retained by the health care professional who provides services to the dental health care employees. The medical record contains the hepatitis B vaccination status, including the dates of the hepatitis B vaccination and the written opinion of the health care professional regarding the hepatitis B vaccination.

If an occupational exposure incident occurs, reports are added to the medical record to document the incident, and the results of testing following the incident, as well as the written opinion of the health care professional. The medical record must also indicate what documents have been provided to the health care provider. Medical records must be maintained for 30 years after the employee's last date of employment.

The confidentiality of medical records must be emphasized. No medical record or part of a medical record is to be disclosed, except to the employee or anyone having written consent from the

employee; to representatives of the Secretary of Labor, on request; or as required or permitted by State or Federal law.

Training records

Training records documenting each training session must be maintained by the base dental service for 3 years.

Training records must include:

- The date of training.
- A content outline.
- The trainer's name and qualifications.
- The names and job titles of all persons attending the training.

Upon request, both medical and training records must be made available to the Assistant Secretary of Labor, Occupational Safety and Health. Training records must be made available to employees or employee representatives upon request. Medical records can be obtained by the employee or anyone having the employee's written consent.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

001. The infection control program

1. What is the objective of infection control?

2. What are the goals of the USAF Dental Service Infection Control Program?

3. What agency periodically publishes and distributes updated guidelines that reflect current standards for the USAF Dental Infection Control Program? What level of command directs this publication?

4. What are these guidelines designed to comply with? What takes precedence over these guidelines?

5. What nonregulatory agencies issue guidelines and recommendations that are used as references in the development of dental service infection control and employee protection programs?

6. How are local dental operating instructions for infection control determined?

7. Match the positions in Column B with the descriptions in Column A. Column B items will be used more than once.

Column A

- ____(1) Advises HQ USAF/SG on current issues relevant to dental infection control and occupational exposure to infectious disease.
- ____(2) Appointed by the DSC.
- ____(3) Opens and maintains lines of communication with federal regulatory and advisory agencies.
- ____(4) Develops and implements the base dental service infection control program.
- ____(5) Develops and publishes HQ USAF/SG approved guidelines for the USAF Dental Infection Control Program.
- ____(6) Represents the dental service on the MTF infection control committee.
- ____(7) Acts as a liaison between other USAF consultants in related areas.
- ____(8) Responsible for ensuring initial, annual, and update training for dental personnel on dental infection control and occupational exposure to blood-borne pathogens.
- ____(9) Appointed by the USAF Assistant Surgeon General for Dental Services.

Column B

- a. Special Consultant for Infection Control
- b. Dental Infection Control Officer

8. Who assumes overall responsibility for overseeing the dental service infection control and occupational safety programs within the base dental service?
9. List and briefly explain the three recommended methods for measuring the effectiveness of the infection control program.

002. Occupational exposure to blood-borne pathogens

1. What is occupational exposure?
2. What comprehensive federal rule sets forth specific requirements to prevent the transmission of blood-borne diseases to employees?
3. Define blood-borne pathogens.
4. How can the significant health risks faced by employees be minimized or eliminated?

5. What forms the basis for the employee protection program for dental service personnel?
6. What agency requires the exposure control plan, and what are the requirements?
7. Who conducts an occupational exposure determination in accordance with current OSHA guidelines, and what is included?
8. What is the definition of occupational exposure on which exposure determination must be based?
9. Who must develop a training program in accordance with current OSHA guidelines on controlling occupational exposure to blood-borne pathogens in dentistry?
10. List six of the thirteen minimum requirements of the training program according to the OSHA Standard.
11. What is an exposure incident? Why should personnel immediately report exposure incidents?
12. If an employee has had an exposure incident, what test is accomplished if the employee consents and why?
13. Define –source individual.¶
14. What is required in most states in order to test the source individual’s blood?
15. How are the source individual’s blood test results made available to the exposed employee?
16. Following the post-exposure evaluation, how does the employee obtain a copy of the health care professional’s written opinion to the employer?
17. What does the blood-borne pathogens standard require that medical records contain?

18. Who maintains the medical record?
19. How long must medical records be maintained?
20. To whom may the medical record or a part of it be disclosed?
21. Who maintains the training records, and for what length of time? What must training records contain? Training records must be made available to whom?

1-2. Transmission and Prevention

To fully understand infection control, you must have a basic understanding of the methods by which diseases are transmitted. Preventing transmission of diseases in dentistry requires controls. OSHA's preventive measures, including hepatitis B vaccination, standard precautions, engineering and work practice controls, personal protective equipment, and housekeeping measures help reduce the risk of occupational exposure.

3. Disease transmission and reduction

The term *sepsis* means the presence of disease-producing microorganisms. *Asepsis* is the absence of all pathogenic microorganisms. Asepsis can be achieved on inanimate objects, but *not* on people. The goal of aseptic techniques is to break the chain of infection by eliminating the possibility of disease transmission. Asepsis is essential to minimize the hazards encountered by individuals exposed to bacteria, fungi, and viruses.

Disease transmission

Occupational exposure puts the dental health team at risk. The highest concentration of microorganisms is found 2 feet in front of the patient, where the dental health team is usually positioned. Opportunities for parenteral contact take place when the mucous membranes or skin is pierced through needle sticks, cuts, and abrasions. Constant awareness and preventive action are essential on the part of all dental personnel. Diseases are transmitted by objects and human sources in several ways. Cross-contamination and the spread of infection can occur between patients, patients and personnel, personnel themselves, and personnel and their families.

Microorganisms can be transferred from person to person by direct contact with infectious lesions, or infected saliva or blood. This frequently occurs through an open wound or lesion, such as a cut or hangnail. Transfer of microorganisms, which occurs from contaminated objects, such as instruments or needles, is considered *indirect* transmission. Contaminated objects or surfaces are considered to have the presence, or the reasonably anticipated presence, of blood or other potentially infectious materials. Other potentially infectious materials include, but are not limited to, the following body fluids:

- Semen.
- Vaginal secretions.
- Saliva in dental procedures.

- Any body fluids in situations where it is difficult or impossible to differentiate between body fluids.

Saliva is included because it may be mixed with blood in some dental procedures. For this reason, saliva should be treated as potentially infectious even though it is believed that blood-borne diseases are not transmitted by saliva itself.

Dental aerosols are tiny, mistlike particles of contaminated water, blood, saliva, and respiratory secretions generated from the patient's mouth during dental procedure. Aerosols are produced during the use of handpieces, air-water syringe, ultrasonic scaler, prophylaxis jet, and by tooth brushing. Organisms in the aerosols may stay airborne for a period of time, or they may fall rapidly and contaminate the environment and people in the dental treatment room (DTR). Some organisms can survive on objects such as countertops, sinks, and DTR equipment for extended periods of time and provide a source of cross-infection. Aerosols can be a source of transmission for respiratory infections.

Along with aerosols, larger droplets of saliva-borne microorganisms and debris known as spatter can contaminate the air. Spatter droplets are usually large enough to be visible. Because spatter droplets move further, the treatment area surfaces become contaminated.

Reduction of aerosol production

There are a number of ways to control and reduce the amount of aerosols and spatter generated during dental treatment. Using the rubber dam during dental procedures, when this type of isolation is practical, reduces aerosol production. Using high volume evacuation (HVE) during procedures involving the high-speed handpiece or when rinsing the mouth also reduces aerosols and spatter. When using the air-water syringe, apply water to the area, followed by air, rather than dispensing both at the same time which produces a forced spray of water. Limit the use of bristle brushes because these generate more spatters during polishing procedures than rubber cups or polishing points.

The bacterial count in the aerosols generated during dental treatment can be reduced approximately 75 percent by having the patient rinse with water before dental treatment, and 90 percent by brushing the teeth. Having the patient use an antiseptic mouthwash before treatment can reduce the bacterial count by 98 percent.

Microorganisms retracted up into the handpiece or water spray hose can be transmitted into the aerosols when these items are used. Daily flushing of water lines and installing anti-retraction valves will reduce but not eliminate microbial levels in the dental unit water supply. The potential for exposing the patient to residual germicide points out the need for careful training to ensure that proper technique for treating the units is followed. Air Force and CDC guidelines recommend flushing water and air from any device connected to the dental water system that enters the patient's mouth (e.g., handpieces, ultrasonic scalers and air/water syringes) for a *minimum* of 20 to 30 seconds between patients. This is intended to physically flush out patient material that may have entered the turbine, air, or waterlines. Sterilization of handpieces and air/water syringe tips is required between patients. Disposable syringe tips are an acceptable alternative. Periodic testing of anti-retraction valves must be performed by medical equipment repair personnel on a regularly scheduled basis.

A dental unit equipped with a separate water reservoir can eliminate bacterial and fungal contamination when it is maintained with specific disinfection procedures. Use commercially available dental waterline products obtained by your clinic according to manufacturer instructions. These treatment products can be used periodically (once a week) or continuously (added to the separate water reservoir each time it is filled). Again, follow the manufacturer's instructions.

Cross-contamination due to aerosols and spatter can be controlled by using protective barriers to cover countertops, keeping all clean and sterile supplies in closed containers, drawers, or cabinets, and disinfecting all contaminated surfaces thoroughly between patients. Providers and assistants must protect themselves from aerosols and spatter through the use of Personal Protective Equipment (PPE).

Reduce exposure to aerosols and spatter by observing proper patient-operator positioning and through effective tissue retraction. Exposure to airborne contaminants can be reduced by maintaining a safe operating distance from the patient's mouth, retracting soft tissues so that liquid aerosols and spatter are reflected away from the health care personnel, and operating from behind rather than in front of the patient.

4. Hepatitis B vaccination and standard precautions

Dental personnel, including civilian employees, volunteers, and dental laboratory personnel, who perform tasks where there is exposure to blood and OPIM, must be offered hepatitis B vaccination in accordance with current OSHA requirements and Air Force policies.

Hepatitis B vaccination

OSHA requires that hepatitis B vaccination be made available within 10 working days of initial assignment to every employee whose job classification or tasks results in occupational exposure. Hepatitis B vaccination and vaccine must be made available without cost to the employee, at a reasonable time and place for the employee, and by, or under the supervision of, a licensed health care professional along with a copy of the blood-borne pathogens standard. The health care professional will provide the employer with a written opinion stating whether hepatitis B vaccination is indicated for the employee, or if the employee has received such vaccination.

Employers are not required to offer the hepatitis B vaccination to employees who have previously completed the vaccination series, when immunity is confirmed through antibody testing, or if the vaccine is contraindicated for medical reasons. Employees may decline antibody testing and still be vaccinated. Following appropriate training about hepatitis B and vaccination, employees who still decline the vaccination must sign a statement to that effect. Employees who continue to be at occupational risk for hepatitis B may request and obtain the vaccination at a later date. The hepatitis B vaccination series must be administered according to the current guidelines of the US Public Health Service, including future recommendations for routine booster doses.

Standard precautions

The CDC has warned dental health care personnel that medical histories and physical examinations cannot be relied on to identify all patients infected with viruses that cause hepatitis, AIDS, and other blood-borne pathogens. Furthermore, extended periods often exist between the time a person becomes infected with a virus and the time when laboratory tests can detect the associated antigens or antibodies. In the case of HIV, this period may be months or years. Consequently, even if patients test negative, they may still be infectious.

Standard precautions apply standards of infection control based on the assumption that all patients are potential carriers of infectious diseases. Dental personnel must assume that all body fluids and contaminated instruments and materials are infectious and routinely use standard precautions to protect themselves and their patients.

Because OSHA assumes that saliva in the dental setting is contaminated with blood, it is categorized as OPIM and considered to have the same infectious potential as blood. Since all blood and OPIM must be considered equally infectious, the degree of employee protection required for a given procedure must be the same for each patient. The decision to adopt additional protective measures should be based on the potential risk of exposure to blood or OPIM posed by the procedure to be performed, rather than on any assumptions about the potential infectivity of the patient.

Patient management

All USAF base dental services must adopt the standard blood and body fluid precautions that are recommended by the CDC and required by OSHA. The use of high-risk patient treatment protocols are discontinued in both dental clinical and laboratory areas.

Since all patients are assumed to be infectious, access to care must not be delayed or denied to patients solely on the basis of a known or suspected positive for blood-borne pathogens. Requests for an immunization exam of patients should be made on the basis of medical considerations and routine treatment should *not* ordinarily be deferred pending results of those tests.

The decision to defer treatment until the present illness is resolved should be based on the provider's best clinical judgment. This condition includes patients who have symptomatic infectious diseases transmissible by nonparenteral routes (e.g., influenza, streptococcal pharyngitis, recurrent herpes, and herpes labialis).

Take special care when treating immunocompromised patients or those individuals at risk for specific postoperative infections (e.g., transplant patients, symptomatic AIDS patients, or patients requiring infective endocarditis prophylaxis) in order to prevent the development of infections. Medical consultation in such cases is strongly recommended.

5. Engineering and work practice controls

Engineering and work practice controls are the primary methods used to control the transmission of HBV and HIV in the dental setting. Personal protective clothing and equipment are also necessary when occupational exposure to blood-borne pathogens remains even after instituting these controls.

Engineering controls

When applied to the DTR, these controls isolate or remove the blood-borne pathogens hazard from healthcare personnel. Rubber dams, high-speed evacuators, and special containers for contaminated sharp instruments are examples of engineering controls. Engineering controls must be examined and maintained or replaced, on a scheduled basis. These engineering controls are used in combination with work practice controls.

Work practice controls.

These controls reduce the likelihood of exposure by altering the manner in which the task is performed. All procedures should be performed in a way that minimizes splashing, spraying, spattering, and generating droplets of blood or other potentially infectious materials. This can be as simple as readjusting the positioning of the dental chair. Work practice requirements include the following:

- Washing hands immediately, or as soon as feasible, after skin contact with blood or other potentially infectious materials occurs and after removing gloves or other PPE.
- Flushing mucous membranes immediately, or as soon as feasible, if they are splashed with blood or other potentially infectious materials.
- Prohibiting recapping, bending, or removing contaminated needles from syringes (unless required by the dental or medical procedure) in which case, it must be done by mechanical means, such as the use of forceps, or using a one-handed technique. For example, recapping is permitted when administering multiple injections of local anesthesia.
- Eliminating the shearing, cutting, and breaking of contaminated needles. Discarding contaminated needles and disposable sharps (such as endodontic files or dental wires with exposed ends) in containers that are closable, puncture-resistant, leak proof, and colored red or labeled with the biohazard symbol. These containers must be easily accessible, maintained upright, mounted in a lockable fixture, and not allowed to overfill. Labeling requires a fluorescent orange or orange-red label with the biological hazard symbol, along with the word *biohazard* in a contrasting color, affixed to the bag or container (fig. 1-1).



Figure 1-1. Biohazard symbol.

- Placing contaminated, reusable sharp instruments in containers that are puncture-resistant, leak proof, and colored red or labeled with the biohazard symbol until properly processed. Reusable sharps must *not* be stored or processed in such a way that employees are required to reach into the container by hand to retrieve the instruments.
- Prohibiting eating, drinking, and smoking, applying cosmetics, and handling contact lenses in areas where there is occupational exposure, such as in a dental treatment room or processing areas.
- Eliminating the storage of food and drink in refrigerators, cabinets or shelves, and on countertops or benchtops where blood or OPIM are present.
- Storing, transporting, or shipping blood or OPIM, (e.g., extracted teeth, tissue, and impressions) that have not been decontaminated in containers that are closed, prevent leakage, and are labeled with a colored or biohazard label.

6. Personal protective equipment (PPE)

PPE is specialized clothing or equipment worn by personnel to protect themselves from exposure to blood or other potentially infectious materials. Personal protective equipment must not allow blood or other potentially infectious materials to pass through to clothing, skin, or mucous membranes. Since the concept of standard precautions assumes that all patients present for treatment are potentially infectious, the type and characteristics of the PPE will depend upon the task and reasonably anticipated degree of exposure to blood and OPIM during a given procedure. Gloves, long-sleeved clinic smocks or lab coats, and masks with eye protection or the combination of chin-length face shields and masks must be worn whenever splashes, spray, spatter, or droplets of blood or other potentially infectious materials may be generated. All PPE must be removed when leaving the work area.

Principles of standard precautions also apply to resuscitation efforts. Protective equipment, such as mouthpieces, resuscitation bags, or other ventilation devices, must be available.

OSHA requires specific responsibilities of the employer for personal protective equipment. At the employer's expense, responsibilities regarding PPE include:

- Providing, maintaining, and replacing PPE.
- Ensuring accessibility in appropriate sizes.
- Providing hypo-allergenic gloves, glove liners, powderless gloves or other similar alternatives, if the employee has an allergy to the gloves usually provided.
- Ensuring employee use.
- Laundering reusable items and discarding disposable items.

Gloves

Most of the time, you will have a variety of breaks, small cuts, scratches or chapping of the hands. Any of these can be an entry for a variety of viral and bacterial organisms. Gloves provide an effective barrier against the entry of serious pathogens, including those responsible for syphilis, hepatitis, and other diseases transmitted by the blood or saliva of infected patients. Gloves must be worn when hand contact with blood, saliva, mucous membranes, or surfaces contaminated with body fluids or secretions is reasonably anticipated. Gloves must also be worn when handling soiled or contaminated instruments, linen, surfaces, or supplies and when handling contaminated materials, such as impressions or prostheses.

Several types of gloves are suitable for dentistry. The type of procedures performed determines the type of gloves worn.

Type of gloves	Procedure Used For
Sterile surgical	The highest quality, most expensive, and best fitting. They are used for surgical or invasive procedures where maximum protection against infection must be provided for the patient and dental health team.
Procedural gloves	Manufactured using the same process as sterile surgical gloves; however, these gloves are nonsterile and are not individually wrapped in pairs. They are sized the same as surgical gloves and packaged in a divided container, with right-hand gloves on one side and left-hand on the other side. Procedural gloves offer the highest quality and best fit at a greatly reduced cost when sterile surgical gloves are <i>not</i> required.
Examination	The least expensive type which is nonsterile and commonly used in routine dental procedures. Nonsterile gloves serve strictly as a protective barrier for the wearer.
Nonpowdered surgical gloves or vinyl examination (latex-free)	Some individuals may develop hypersensitive reactions either to the latex material or cornstarch lubricant. Using these gloves will usually alleviate this problem.
Lightweight plastic	Used by food handlers, may be worn over exam or surgical gloves during secondary procedures. These overgloves are not a replacement for wearing or changing latex gloves and are removed before resuming any patient treatment that was in progress.
Heavy-duty utility	Puncture-resistant and must be worn when handling and cleaning contaminated instruments. They should also be worn when handling contaminated supplies and general treatment room cleaning. These gloves can be washed, disinfected or sterilized, and reused. Utility gloves must be discarded if they are deteriorated or fail to function as a barrier.

Examination, procedural, surgical, and lightweight plastic gloves are manufactured as single-use disposable items. They are for use on one patient and then must be discarded. OSHA requires that these types of gloves must be replaced as soon as practical when contaminated (i.e., after each patient at a *minimum*), and as soon as feasible when torn or punctured. These gloves may *not* be washed for reuse. Reuse increases infection risks to dental personnel and to the patient. The present composition of the gloves does not permit them to be safely washed and reused. Contact with hot water, soaps, detergents and other chemicals can negatively affect glove materials by making them —atckyl and more prone to tearing.

Always inspect your gloves carefully before putting them on as well as during treatment for signs of tears, punctures, or tackiness. Minute holes and tears may already exist in new gloves and they should be carefully inspected. If gloves are damaged during treatment, immediately remove the gloves, wash your hands thoroughly, and replace the damaged gloves before continuing the dental procedure. Rings, watches, and long fingernails should not be worn under gloves because of the potential for harboring microbes and causing holes in the gloves. If you must leave the treatment room or touch surfaces that are not routinely treated or covered between patients, remove the gloves and wash your hands prior to contact with other surfaces. Rewash your hands and put on new gloves before returning to patient treatment. If you are not leaving the treatment room but need to touch surfaces not routinely treated or covered between patients, you may use the lightweight plastic gloves as overgloves.

Masks and eyewear

A well-fitting mask that covers the mouth and nose is an effective means of protection in two ways. First, it protects the patient from contamination by a member of the dental health team who has a cold or similar condition transmitted by respiratory droplets. Masks are also a source for protecting the dental health team from bacteria or virus containing aerosols. Because larger spatter particles of blood, saliva and oral debris containing aerosols may be generated during some procedures, wearing a face mask is mandatory.

Masks are available in a wide variety of styles and materials: paper, cloth, and foam are the *least* effective while fiberglass and synthetic fiber the *most* effective. Masks are disposable and should be discarded after each patient. Wear a clean mask for each patient visit. If the mask becomes wet or visibly contaminated, replace it because it is no longer effective. Never wear masks outside of the patient treatment areas.

During dental treatment, large particles of debris and saliva can be projected towards the faces of the dental health team. These particles can contain large concentrations of bacteria and can physically damage the eyes. Protective eyewear or safety glasses can prevent not only physical injury from flying debris or accidental trauma, but also prevent infection from bacteria-laden aerosols and spatter. Highspeed handpieces and ultrasonic scalers increase the presence of aerosols with large amounts of infectious bacteria, creating a risk to both the dental health team and patient. Herpes simplex virus is an example of a pathogen capable of transmission from saliva into the eye by means of aerosols or spatter droplets. This leads to an infection, recurrent herpetic keratitis, which causes impaired vision and possible blindness. Pieces of calculus fractured from a tooth and projected out of the mouth, or slurry of polishing paste and saliva spattered on your face can easily cause damage to the eyes when safety glasses are not worn. Evidence of the spatter and debris is easily seen on the safety glasses following patient treatment.

The patient's eyes are also highly vulnerable to damage from oral debris and aerosols, and from mishandled or falling materials or instruments. With the patient in the supine position, an incorrect instrument or supply transfer over the patient's face could cause trauma to the eyes or impaction of a foreign body.

Because of possible damage to the eyes of both the dental health team and patient, each must wear protective eyewear when spatter or aerosols are likely to be created. Eyewear must be glasses with solid, not perforated, side shields or goggles which may fit over the regular corrective glasses. Contact lenses and personal eyewear do *not* afford adequate protection. Between each patient treatment, wash contaminated safety glasses thoroughly with antiseptic soap and water, rinse well, and disinfect with an intermediate level disinfectant that does not damage the glasses. An alternative is to use single-use, disposable protective eyewear.

Chin-length, plastic face shields provide protection to eyes, nose, and mouth without some of the discomfort of close fitting masks and do not interfere with communication. However, because these shields don't provide the same level of protection against aerosol contamination, they must be worn

with face masks. Most dental face shields also do *not* offer protection from high velocity projectiles. Completely clean with soap and water and disinfect face shields after each patient

Clothing

Dental aerosols, splashes, spray, and spatter also contaminate clothing worn by the dental health team. Therefore, dental personnel's personal hygiene is important in controlling disease transmission. It begins with simple things such as wearing freshly laundered PPE clothing daily. Cotton or cotton/polyester long-sleeved smocks or lab coats are usually satisfactory barriers for routine dental procedures. Wear long-sleeved PPE in combination with head covers when exposure to blood and OPIM in the form of spray, spatter, and aerosols is anticipated. If long-sleeved surgical scrub tops are worn for procedures where significant exposure to blood or OPIM is reasonably anticipated, the entire ensemble is considered to be PPE. Fluid-resistant gowns are required if it is anticipated that large amounts of blood, saliva or other body fluids will soak through the gown. Wear shoe covers if there is a potential contamination. Change your clothing sooner if it becomes visibly soiled with blood or OPIM.

The basic clothing ensemble selected for wear in the dental treatment area is referred to as clinical attire. According to OSHA, general work clothes (clinical attire) *not* intended to function as protection against a hazard, are *not* considered to be PPE. Therefore, supplement general work clothes with PPE to avoid contamination by wearing reusable or disposable gowns, or smocks when exposure to blood or OPIM is reasonably anticipated. In addition, skirts or dresses are not recommended for wear during procedures where exposure to blood or OPIM is anticipated, unless the skin is protected by PPE. OSHA requires that the employer must launder clinical attire contaminated during the course of clinical treatment. Clinical attire is considered contaminated when visibly soiled with blood or OPIM, or when worn without additional PPE for procedures where exposure to blood or OPIM occurred.

Situations that require wearing long-sleeved clothing or gowns in combination with head and shoe covers include, but are not limited to:

- Ultrasonic scaling.
- High or low speed handpieces.
- Spraying air-water into patient's mouth.
- Surgical procedures using rotary or ultrasonic instrumentation.
- Surgical procedures where unusually heavy bleeding may be anticipated (e.g., maxillofacial reconstructive surgery, trauma surgery).
- Manual decontamination of dental instruments where spatter or aerosols may be generated. Remove all PPE worn during instrument decontamination procedures prior to returning to patient treatment.

Protective clothing and equipment must be worn only in the dental treatment area. Remove it immediately or as soon as feasible when the clothing or equipment is penetrated by blood or other infectious materials. PPE is not permitted in eating areas or restrooms, and must be removed before leaving the work area in order to prevent contamination of others. There are several reasons for this practice. First, clothing worn outside the dental environment may introduce microorganism from the outside into the treatment environment. A greater risk is the transfer of pathogens contacted during patient treatment to environments outside the dental setting, such as your car, home, family, and friends. Even shoes worn during patient treatment should be left at the dental clinic and not worn home where small children might play with or handle them.

7. Handwashing and housekeeping

Gloving does not replace handwashing! Handwashing is one of the most important ways to prevent the transfer of microorganisms from one person or object to another person.

Handwashing

Handwashing is the vigorous rubbing together of well-lathered soapy hands, ending with a good rinsing. Thoroughly clean and wash hands and nails before gloving, and immediately after the removal of gloves. This keeps the level of skin bacteria to a minimum and reduces the build-up of skin bacteria that multiply under the gloves.

You must immediately, or as soon as feasible, wash your hands and any other skin with soap and water, or flush mucous membranes with water following contact with blood or OPIM. In addition, you must wash your hands both before and after lunch, taking a break, or using the bathroom. You must also wash your hands at the beginning and end of each duty day as well as immediately after the removal of personal protective equipment.

Fingernails must be kept short to prevent interference with patient comfort and tearing of disposable gloves, and to allow effective instrument handling during intraoral procedures. The protected area under the nails is a potential source of cross-contamination because it harbors bacteria. For this reason, handwashing includes a thorough cleaning around and under nails with an orange wood or rounded plastic stick. Also, all jewelry, including rings, watches and bracelets, must be removed since it harbors bacteria and may tear the gloves.

At the beginning of the duty day, perform an initial handwashing or scrub with an approved antimicrobial handwashing agent. The steps for proper handwashing are:

Proper Handwashing: Initial Steps	
Step	Action
1	Remove all jewelry and check your hands for small cuts, abrasions, and hangnails.
2	Clean your hands, nails, and forearms with a liquid antimicrobial handwashing agent for 1 minute. Using a liquid antimicrobial handwashing agent enhances the destruction of bacteria rather than bar soap, which serves as a source for bacteria growth after use.
3	Be sure to scrub all surfaces, including parts of the thumb and areas of the finger tips which are frequently missed.
4	Start from the fingertips down toward the elbow and rinse well with cool-to-lukewarm running water for 10 seconds, or until all soap is removed.
5	Lather your hands again with the liquid antiseptic by rubbing for 10–20 seconds and then repeat the rinsing procedure.

After your initial handwashing, there will be many other times you must wash your hands again.

A surgical scrub is similar to initial handwashing; however, you must scrub for 2 to 6 minutes, using multiple scrub and rinse cycles. You must also dry with sterile towels and don sterile gloves.

There are no excuses for not washing your hands. If a situation arises in which handwashing facilities are not readily available, OSHA requires using an appropriate antiseptic hand cleanser.

Alcohol-based Hand Rub Procedure	
Step	Action
1	Check hands; make sure they are clear of blood and saliva.
2	Place proper amount of solution in palm of your hand (according to manufacturer).
3	Rub your palms together.
4	Rub solution between your fingers.
5	Rub solution over back of hands.

Housekeeping

The OSHA requirements for housekeeping include equipment, waste, and laundry.

Equipment

OSHA requires the employer to make certain that the workplace is clean and sanitary. When contamination occurs through splashes, spills, or other contact with blood and OPIM, upon completion of procedures decontaminate all work surfaces, equipment, and other reusable items with disinfectant.

If surfaces, equipment, and other items, such as light handles or trays, have been protected with coverings, such as plastic wrap, foil, or imperviously-backed absorbent paper, replace these materials after each patient and at the end of the workshift. Inspect reusable receptacles, such as bins, pails, and cans that are likely to become contaminated, and decontaminate on a regular basis and when visibly contaminated.

You may clean up potentially contaminated broken glass with a brush or tongs; but *never pick up broken glass with your hands, even if wearing gloves!*

Equipment which has had contact with blood or OPIM, and been serviced either on-site or shipped out of the facility for maintenance or other service, must be decontaminated to the extent feasible. If decontamination isn't possible the item must be labeled as a biohazard and the parts not able to be decontaminated must be indicated.

Waste

Waste removed from the facility may be regulated by a combination of local, state, and federal laws. To comply with the blood-borne pathogens standard, special precautions are necessary when disposing of contaminated sharps and other regulated waste. Regulated waste includes:

- Liquid or semi-liquid blood or OPIM.
- Items contaminated with blood or OPIM that would release these substances in a liquid or semi-liquid state if compressed.
- Items caked with dried blood or OPIM and capable of releasing these materials during handling.
- Contaminated sharps.
- Pathological and microbiological wastes containing blood or OPIM.

Contaminated sharps are any contaminated objects that can penetrate the skin including, but not limited to, needles, scalpels, broken glass, broken capillary tubes, dental burs, and exposed ends of dental wires. Dispose of contaminated disposable sharps immediately, or as soon as feasible, in containers that are closable, puncture-resistant, leakproof, and colored red or labeled *biohazard* and marked with the biohazard symbol. These containers must remain upright throughout use, be replaced routinely, mounted in a lockable fixture, and not be overfilled. When moving containers of contaminated sharps; close them prior to removal or replacement in order to prevent spillage or protrusion of contents during handling, storage, transport, or shipping.

Contain other regulated waste generated from dental procedures in closable bags or containers that prevent leakage and are colored red or labeled *biohazard*.

Laundry

Contaminated laundry is any laundry soiled with blood or other potentially infectious materials, including saliva. This includes *all* protective clothing and *only contaminated clinical attire*.

Contaminated laundry may *not* be taken home to wash. It must be handled as little as possible, and placed in bags or containers in the area where it is used. The bags or containers must either be red or labeled with the biohazard symbol and the word *biohazard*. If all personnel at the facility and off-site laundry use standard precautions in the handling of all soiled laundry, alternative labeling or color-

coding is sufficient. If the contaminated laundry is wet, the bags or containers must prevent leakage and soak-through. Protective gloves and other appropriate PPE must be worn when handling contaminated laundry.

Clinical attire can be commercially cleaned or placed in a plastic bag and laundered at home. Keep clinical attire separate from other clothing before and during laundering and wash in hot water, with regular laundry detergent and bleach (if possible).

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

003. Disease transmission and reduction.

1. Define the terms *sepsis* and *asepsis*.
2. What is the goal of aseptic techniques?
3. Where is the highest concentration of microorganisms found in the dental environment?
4. How can microorganisms be transferred from person to person?
5. Describe ~~—~~indirect transmission.
6. What are considered OPIM?
7. For dental procedures, why is saliva included as OPIM?
8. What are dental aerosols? When are large amounts produced?
9. What is spatter? Where is it most likely to accumulate?
10. What are the ways to control and reduce the amount of dental aerosol and spatter generated during dental treatment?

11. How can the bacterial count in the aerosols generated during dental treatment be reduced?
12. How can the handpiece or water spray hose transmit microorganisms? What will reduce microbial levels in the dental unit?
13. What is required of handpieces and air/water syringe tips between patients? What is an alternative for air/water syringe tips?
14. What maintenance is required on anti-retraction valves?
15. What device can eliminate bacterial and fungal contamination when maintained with specific disinfection procedures?
16. How can cross-contamination due to aerosols and spatter be controlled?
17. How must providers and assistants protect themselves from aerosols and spatter?
18. What other methods can reduce exposure to aerosols and spatter?

004. Hepatitis B vaccination and standard precautions

1. Who must be offered the hepatitis B vaccination in accordance with current OSHA requirements and Air Force policies? During what time frame must it be made available?
2. Under what conditions must the hepatitis B vaccination and vaccine be made available?
3. Who will provide the employer with a written opinion stating whether hepatitis B vaccination is indicated for the employee, or if the employee has received such vaccination?
4. In what situations are employers *not* required to offer the hepatitis B vaccination to employees?

5. How must the hepatitis B vaccination series be administered?
6. Why are standard precautions necessary?
7. What is the assumption which standard precautions are based upon? Briefly explain.
8. Why must the degree of employee protection required for a given procedure be the same for each patient?
9. What should the decision to adopt additional protective measures be based upon?
10. Why must access to care not be delayed or denied to patients solely on the basis of known or suspected positive for blood-borne pathogens?
11. In what situations should the decision to defer treatment, until the present illness has resolved, be based on the provider's best clinical judgment?
12. Why should special care be taken when treating immunocompromised patients or those individuals at risk for specific postoperative infections? What is indicated in such cases?

005. Engineering and work practice controls

1. What are engineering controls? List some examples.
2. What are work practice controls?
3. Give an example of a work practice control to minimize splashing, spraying, spattering, and generating droplets of blood or OPIM when performing procedures.
4. What work practice controls apply to handwashing?

5. Using work practice controls, when and how can contaminated needles be recapped?
6. Describe the work practice controls for discarding contaminated needles and disposable sharps.
7. Describe how the containers must be labeled.
8. Explain the work practice controls for contaminated, reusable sharp instruments.
9. What is prohibited in areas where there is occupational exposure, such as a dental treatment room or reprocessing area?
10. In what areas must the storage of food and drink be eliminated?
11. Using work practice controls, how can extracted teeth, tissue, and impressions that have not been decontaminated be stored, transported, or shipped?

006. Personal protective equipment

1. What is PPE? What must it not allow?
2. What determines the type and characteristics of the PPE?
3. What PPE must be worn whenever splashes, spray, spatter, or droplets of blood or OPIM may be generated?
4. What must be done with PPE prior to leaving the work area?
5. What are the specific responsibilities which OSHA requires of the employer for PPE?
6. When must gloves be worn?

7. Briefly describe each of the following types of gloves:
 - a. Sterile surgical.
 - b. Procedural.
 - c. Examination.
 - d. Vinyl examination.
 - e. Lightweight plastic.
 - f. Heavy-duty utility.
8. Why are examination and surgical gloves disposable, single-use items?
9. What effects can contact with hot water, soaps, detergents, and other chemicals have on disposable gloves?
10. What must you do if your gloves are damaged during treatment?
11. Why should rings, watches, and long fingernails not be worn under gloves?
12. In what two ways is a well-fitting mask that covers the mouth and nose an effective means of protection?
13. When is wearing a face mask mandatory? Masks must *never* be worn where?
14. When should the mask be disposed of and replaced?
15. What can protective eyewear or safety glasses prevent?
16. Give an example of a pathogen capable of transmission from saliva into the eye by means of aerosols or spatter droplets. What can this cause?

17. Who must wear protective eyewear, and when?
18. What type of eyewear must be worn?
19. What must be done with contaminated safety glasses between patient treatments?
20. What must be worn with chin length plastic face shields? What must be done with face shields after each patient treatment?
21. How is the personal hygiene of dental personnel related to clothing?
22. Define clinical attire. Why may it vary?
23. When does OSHA require general work clothes (clinical attire) to be supplemented with PPE?
24. When are skirts or dresses *not* recommended for wear?
25. What does OSHA require if clinical attire becomes contaminated during the course of treatment? When is it considered contaminated?
26. What type of clothing must be worn as PPE to avoid contamination of general work clothes?
27. When must long-sleeved PPE be worn in combination with head covers?
28. When are fluid-resistant gowns required?
29. When are shoe covers worn?

30. List five of the six situations that meet the criteria for the wear of long-sleeved clothing or gowns in combination with head and shoe covers.
31. When must PPE be removed? Why?

007. Handwashing and housekeeping

1. Why must hands and nails be thoroughly cleaned and washed before and immediately after the removal of gloves? At what other times must hands be washed?
2. Why must fingernails be kept short?
3. Why must all jewelry, including rings, watches, and bracelets, be removed?
4. When must you perform an initial handwashing? Describe the initial washing procedure.
5. Why is an approved liquid antimicrobial handwashing used and when can you use it?
6. What areas of the hand are frequently missed in handwashing?
7. How does a surgical scrub differ from the initial handwashing?
8. What does OSHA require if a situation arises in which handwashing facilities are not readily available?
9. What are the housekeeping requirements for work surfaces, equipment and other reusable items when contamination occurs through splashes, spills, or other contact with blood and OPIM?
10. How is contaminated broken glass cleaned up?

11. What is required when equipment that had contact with blood or OPIM is serviced either on-site or shipped out of the facility for maintenance or other service?
12. What is included as regulated waste?
13. What items are considered contaminated sharps?
14. What is done with contaminated disposable sharps?
15. What are the additional requirements for the containers during use?
16. Describe how to dispose of other regulated waste generated from dental procedures.
17. What is considered contaminated laundry? What items are included?
18. What is done with contaminated laundry?
19. What items must be worn when handling contaminated laundry?

1-3. Cleaning and Disinfection Procedures

One of your greatest responsibilities to the dental patient is to maintain proper cleanliness and infection control standards. You can accomplish this efficiently when you plan ahead and anticipate the needs for treatment of each patient. To fully understand the extent and importance of surface contamination and cleaning, we must begin by identifying and categorizing the surfaces contaminated during dental treatment. Disinfection methods are used only to control contamination on surfaces or items within the DTR that cannot be sterilized. For example, it is not possible to sterilize some pieces of dental equipment and environmental surfaces of the DTR. To prevent possible cross-infection, these items and surfaces must be thoroughly cleaned, disinfected, and may be protected by barriers or surface covers.

8. Identification and cleaning

In the dental environment, surfaces can be contaminated by direct contact with blood, saliva, mucous membranes, or other body fluids, aerosols, spatter droplets generated during dental treatment; or contact with other contaminated surfaces or contaminated hands. Fomites are any inanimate objects or surfaces that act as reservoirs or vehicles for the spread of infectious microorganisms.

Identification of contaminated surfaces

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). By restricting the number of surfaces that fall within the clinical contact category, an effective and efficient infection control routine can be established for a short amount of time between patients.

Identifying Contaminated Surfaces		
Type	Definition	Examples
Clinical Contact	Surfaces that may be touched frequently with gloved hands during patient care or that may become contaminated with blood or other potentially infectious material and subsequently contact instruments, devices, hands, or gloves.	Light handles, switches, dental x-ray equipment, chairside computers, reusable containers of dental material, drawer handles, faucet handles, countertops, pen, telephone handle, doorknobs.
Housekeeping	Surfaces that do not come into contact with devices used in dental procedures.	Floors, walls, sinks.

Cleaning

Cleaning or sanitizing involves the physical removal of germ-laden dust and dirt from equipment and surfaces. The elimination of visible soil by cleaning is the first step in creating a safe treatment environment and must take place prior to the initial placement of protective covers, and disinfection and sterilization processes. Cleaning reduces the number of micro-organisms on surfaces and equipment, thus increasing the effectiveness of protective covers, disinfection, and sterilization. The presence of excessive numbers of microorganisms, soil and organic matter, such as blood or saliva, can inhibit or even prevent methods of disinfection or sterilization from destroying the pathogens. For this reason, routine cleaning of all surfaces in the DTR contacted by patients, providers, assistants, or dental aerosols is required prior to protective covers, disinfection, and sterilization.

Keep DTR sinks clean, and remove any standing water from sink counters following hand-washing. Foot-operated faucets are the best way to reduce contamination during washing. Keep hand faucets clean and disinfected. Because these surfaces may be difficult to disinfect thoroughly, contamination can be reduced by using foot control devices, or by handling them with disposable paper towels rather than contaminated hands.

All surfaces in the treatment room that would be at or above the eye level of the supine patient should be kept especially clean. Not only will these surfaces be contaminated by aerosols produced during dental procedures they are also frequently touched during treatment and are within the viewing range of the patient. All surfaces must be routinely cleaned before being disinfected and/or covered. To check the effectiveness of the DTR cleanliness, it is a good idea to recline in the dental patient chair and take a close look at the DTR from where the patient sits. Cobwebs near the ceiling, a spot of blood on the dental unit, or fingerprints on the light shield, undetected from the provider's or assistant's view, may now be visible. These areas not only indicate inconsistencies or omissions in the cleaning routine but also affect the patient's opinion of the clinic's cleanliness. Patients may view these lapses in sanitization as a reflection of a general lack of concern not only for asepsis but also for their own health and well-being. Attend to areas that need special spot cleaning and dusting whenever necessary, so that visible soil and dust accumulations on surfaces are promptly removed.

9. Principles of disinfection

Disinfection is a process that kills disease-causing microorganisms. However, this does *not* include the destruction of resistant bacterial spores. Disinfection is achieved by either heat or chemical means. In choosing the method of disinfection for the various types of equipment, you must consider the microorganisms targeted and composition of the article to be disinfected.

Targets of disinfection

Disinfectants are defined based upon their effectiveness against bacteria, fungi, and viruses. These microorganisms are divided into six general groups, depending on their relative sensitivity or resistance to chemical disinfectants.

Microorganisms	
Group	Description
Vegetative bacteria	All microorganisms exist in the vegetative state at some time in their life cycle, and in this state they are relatively easy to kill. Vegetative forms of bacteria invalidate growth and nutrition rather than reproduction. Vegetative bacteria have the lowest level of resistance to disinfectant agents.
Spores	Certain bacteria form spores during their life cycle, and these bacterial endospores are the <i>most resistant</i> forms of life known.
Tubercle bacillus	Some organisms, including tubercle bacillus, are entirely vegetative but have a relatively impermeable waxy coating that gives them greatly increased resistance to many agents. <i>Mycobacterium tuberculosis</i> is considered the <i>most resistant</i> microorganism after bacterial endospores.
Fungi	Other types of spores considered in the effectiveness of disinfectants are fungal spores. They are the fourth most resistant to disinfectant agents.
Lipid viruses	Included in the category of lipophilic viruses are the herpes simplex 1 and 2, influenza A ₂ , and HIV. These microorganisms have the second lowest resistance to chemical disinfectants.
Nonlipid viruses	Microorganisms in this category include hydrophilic viruses, such as rotavirus (gastroenteritis) and poliovirus type 2 (polio). These viruses are the third most resistant to disinfectants.

Chemical disinfection

Chemical disinfectants may be used for immersion of small heat sensitive items, or disinfection of surfaces in the DTR. Choose disinfectants according to the range of bacteriostasis or bactericidal activity needed. Chemical disinfectants come in three levels: low, high, and intermediate. Some agents can effectively destroy microorganisms while others only suppress their growth and multiplication. Chemical agents lethal to bacteria are called *bactericides*. Other agents, such as *viricides*, are effective only against viruses, *fungicides* against fungi, and *sporicides* against spores. An agent effective against vegetative bacterial cells but not the more resistant bacteria, such as *Mycobacterium tuberculosis* or HBV, is termed a *germicide*. Agents which are even less effective are termed *bacteriostatic*. These agents inhibit or suppress future bacterial growth but do *not* actually destroy all bacteria present on the affected surface.

Antiseptics are chemical agents used to reduce the number of microorganisms on living tissues, such as in the oral cavity or on the hands of the health care worker. The use of antiseptics can reduce the chances of introducing pathogenic bacteria into the bloodstream during certain procedures. For

example, antiseptics may be used before dental injections to cleanse the area, so the needle will not carry a large number of microorganisms deep into the tissue and blood supply.

Chemical germicides manufactured for disinfection are regulated and registered by the EPA; whereas the Food and Drug Administration (FDA) regulates antiseptic products. The procedures and criteria for product approval are different between these two agencies; therefore, do not attempt to interchange the use of disinfectants and antiseptics.

When disinfecting with chemicals, cleaning or sanitizing is considered an essential preliminary step to the disinfection process. Surfaces must be clean or the agent will not be effective. Thorough cleaning of the surfaces has two effects. It reduces the number of bacteria and removes organic matter, such as blood and tissue, and other debris that may interfere with disinfection. Therefore, you must clean surfaces first. Do not underestimate the importance of adequate cleaning of all contaminated surfaces. Items that cannot be sterilized, disposed of, or covered must be cleaned and treated with an effective disinfecting solution for the prescribed length of time following each patient contact. Chemical agents that function as both cleaners and disinfectants offer the most efficient approach. Water-based disinfectants, especially those that contain a detergent, are effective in the cleaning step. EPA approved surface disinfectants, such as iodophors, synthetic phenolics, and chlorine compounds, can both clean and disinfect.

Prior to beginning disinfection procedures, you must don rubber gloves, face mask, and eye protection to reduce the risk of exposure to chemical disinfectants. When using disinfectants, avoid using spray bottles that generate mists or aerosols; dispensers that generate streams or droplets reduce risks to the eyes, skin, and respiratory system. Do *not* immerse gauze sponges in disinfectants, since the cotton fibers may inactivate some compounds. For the same reason, do *not* wrap items in disinfectant-soaked gauze sponges.

Levels of disinfection

The type of chemical disinfection used depends upon the level of disinfectant required. Chemical disinfectants are classified as high, intermediate, or low-level disinfectants, depending on their range of effectiveness against pathogenic microorganisms. The type and resistance of microorganisms determine the effectiveness of a chemical agent. *High-level disinfectants* are effective against all vegetative bacteria, fungi, and viruses, including the tubercle bacillus, bacterial spores, and viruses similar to the hepatitis virus. Although high-level disinfectants are capable of sterilizing immersed items, these chemicals are often misused. High-level disinfectants should be used for any item that cannot undergo sterilization. Furthermore, the effectiveness of solutions is challenged by the amount of bioburden and cannot be monitored to guarantee the destruction of all microbial forms.

The term —old sterilization is a misnomer and should *not* be confused with accepted methods of sterilization. The ability to kill bacterial spores is an essential criterion for including a chemical in the high-level disinfectant class. *Intermediate-level disinfectants* are effective against all microorganisms, *except* for bacterial spores. Chlorine compounds, iodophors, alcohols, and phenolic disinfectants are included in this level. An intermediate-level disinfectant selected for use in dentistry should be EPA-registered as a tuberculocidal, hospital disinfectant, with appropriate virucidal activity. All surfaces which are not covered with a protective barrier should be treated with an intermediate-level disinfectant. *Low-level disinfectants* have the narrowest antimicrobial range. These agents are only effective against vegetative bacteria and some viruses. They will *not* kill tubercle bacille, bacterial spores, fungi, and nonlipid viruses. Disinfectants in this group include quaternary ammonium compounds, simple phenolics, and detergents.

10. Selection and effectiveness factors of chemical disinfectants

Different factors must be considered when using chemical disinfectant agents. These include the properties of an ideal disinfectant, selection criteria, and effectiveness factors.

Properties of an ideal disinfectant

Selection of appropriate immersion and surface disinfectants can be simplified by comparing the effectiveness of the available agents with the criteria for an ideal disinfectant. You should realize, however, that none of the agents available fulfill all of these criteria.

An ideal disinfectant has the following properties:

Properties of an Ideal Disinfectant	
<ul style="list-style-type: none"> • Widest possible antimicrobial spectrum. • Rapid lethal action on all vegetative forms and spores of bacteria and fungi. • Residual effect on treated surfaces that becomes reactivated when surfaces are moistened. • Active in the presence of bioburden, such as blood, saliva, and feces. • Compatible with soaps, detergents, and other chemicals encountered in use. 	<ul style="list-style-type: none"> • Noncorrosive to instruments and other metal surfaces. • Does <i>not</i> cause disintegration of cloth, rubber, plastics or other materials. • Odorless to permit routine use. • Easy to use. • Economical cost.

Selection

A chemical agent used for disinfection in dentistry must be registered by the EPA as a hospital disinfectant. The designation —hospital disinfectant‡ is given by the EPA to products documented to kill three species of basic test bacteria: *Staphylococcus aureus*, *Salmonella typhimurium*, and *Pseudomonas aeruginosa*. Disinfectants used in dentistry must also be tuberculocidal and virucidal for both lipid and nonlipid viruses. Disinfectants, which destroy these microorganisms, are also effective against HIV and HBV viruses on cleaned surfaces. The following are guidelines which all chemicals selected for disinfection or sterilization in dentistry must meet to prove product effectiveness and user compliance:

- The product must display an EPA number on the product label. This number is proof of the product's registration with the EPA in compliance with federal law. It also proves that the product performs as the manufacturer claims. The EPA number provides reasonable legal protection for the user that only products in compliance with the Federal law are used in patient treatment.
- The product selected must be used in strict compliance with the printed instructions on the label. Chemical and microbiological considerations require use of the product in a disciplined manner to assure the product effectiveness as stated by the manufacturer. Ignoring instructions nearly always reduces microbial control.
- The product should state on the label that it kills *Mycobacterium tuberculosis*. The tubercle bacillus is comparatively difficult to destroy and is used as the standard organism for measuring effectiveness. Tuberculocidal action assures that the product is an intermediate- or higher-level disinfectant and will destroy all pathogens potentially threatening to dentistry.

Effectiveness factors

The effectiveness of both immersion and surface disinfectant agents depends on a number of factors which can be controlled. These factors are discussed in the following paragraphs.

Dilution

Follow the proper dilution, or concentration, of chemical agents according to their label directions, which have been approved by the EPA. You must follow manufacturer's directions that call for the dilution of disinfectants in water rather than alcohol. If not, the cleaning ability of the active agent will be impaired and the alcohol may actually increase the harmful effects of some disinfectants, such as iodophors. Haphazardly estimating the amount of disinfectant agent and water may result in an

ineffective solution. Because the presence of hard water interferes with the effect of certain disinfectants, you should use distilled or at least softened water with these chemicals.

Exposure time

Disinfectants do *not* destroy all microorganisms on contact. Time of exposure depends upon the materials to be disinfected; the quantity, number, and type of organisms; and concentration and rapidity of penetration of the germicide. The time specified by most disinfectant manufacturers for keeping surfaces wet after cleaning is usually 10 minutes or less. Chemicals that require 20 minutes or more to kill tubercule bacillus microorganisms are of limited time value. Most disinfectants currently approved by the EPA were required to supply data for microorganisms killed (kill data) in 5 minutes, in order to be able to recommend 10-minute exposure interval. This provides a 5-minute safety factor. Again, follow the manufacturer's directions.

Temperature

A warm solution is likely to be more effective than a cold one because heat lowers surface tension and increases the speed of chemical reactions in disinfection. Generally, disinfectants are suitable for use at room temperature; however, it is best to read the manufacturer's directions to determine the proper temperature.

pH

Some disinfectants are more active in acid; others in alkaline environments. Deviation from the desired pH directly alters the disinfectant's effectiveness.

Organic matter

The presence of organic matter or bioburden, such as pus, blood, saliva, or dental materials affects the efficiency of disinfectants. Precleaning items and surfaces prior to disinfecting can control the amount of accumulated bioburden. Chemicals can coagulate and combine with proteins and produce barriers or films about the microorganisms that inhibit the disinfectant's penetration into the bacterial cells. Also, all the active ingredients of the solution may become involved with the organic coating so that none will be available to kill the microorganisms. The concentration and nature of the microorganisms will also impact the effectiveness of the chemical agents.

Expiration

To maintain effectiveness do *not* use chemical disinfectant agents beyond their expiration dates. Three terms—shelf life, use life, and reuse life—relate to the expiration of disinfectants.

- *Shelf life* is the time that an agent may be safely stored.
- *Use life* is the life expectancy for the solution once it is activated, but not actually used with contaminated items.
- *Reuse life* is the amount of time a solution can be used and reused once wet or bioburdened instruments or items are used in the agent. Reuse life takes into account a dilution factor caused by added water from wet instruments, effects of soap and other detergents, and evaporation.

Objects disinfected

Because all chemical disinfection is based on a chemical reaction, adequate exposure of the entire surface of the item to the chemical is required. Flat, smooth, nonporous surfaces or items that have been adequately precleaned can be chemically disinfected effectively. Hinged or serrated instruments, such as scissors or forceps, and porous, rough, uneven surfaces are more difficult to disinfect because crevices and small openings prevent adequate penetration. *Do not disinfect when you can sterilize.*

11. Types of chemical agents

Chemical agents are used for several purposes, including surface and immersion disinfection, and immersion sterilization. No single agent can be used for all purposes any more than a single antibiotic can be expected to act against all types of diseases. Carefully study the labels and directions on disinfectants to ensure that the product can do the necessary job.

Clean surfaces and items first. Before placing instruments or other such items in the solution, rinse and drain them thoroughly. Failure to drain these items can result in dilution and a reduction in the effectiveness of the solution. Containers holding solutions must be kept covered to prevent particles from settling on the solution, evaporation of solution, and environmental hazards from emitted fumes. Containers should have labels with the expiration date, name of solution, and dilution of the agent. In order to maintain proper concentrations of solution, to reduce the amount of bioburden, and to prevent the possibility of cross-contamination you need to change solutions frequently.

Many different chemical disinfectants, with varying degrees of effectiveness, are available. The EPA and ADA Council on Dental Therapeutics currently list iodophors, synthetic phenolics, and chlorine-containing compounds as acceptable intermediate hospital-surface disinfectants. These and others are discussed below.

Alcohol

Ethyl and isopropyl alcohols have been used in the past as surface disinfectants and skin antiseptics. Both types of alcohols are effective in the denaturation (change) of cellular proteins and as lipid solvents. In general, alcohols have a broad antimicrobial range of activity under certain conditions. An exposure to a 70 percent concentration of alcohol kills all kinds of vegetative bacteria. Concentrations which exceed 70 percent allow the cell components to resist the desired cellular changes. Unfortunately, alcohols have a number of serious problems inherent with their chemical actions. Alcohols are *not* effective in the presence of tissue proteins, such as those found in saliva and blood, because both tend to inactivate the alcohol. Therefore, alcohols are poor cleaning agents in the presence of bioburden. The rapid evaporation rate of alcohol reduces its activity against viruses in dried blood and saliva commonly found in the spatter created during dental procedures. Other problems include the lack of sporicidal activity, corrosiveness on metals, and damage to rubber and plastics. As a result of these problems with chemical actions of alcohol, the ADA does *not* accept and the CDC does *not* recommend alcohol as a surface disinfectant in the dental environment.

Iodophors

Iodophors are compounds in which surface-active agents serve as carriers and solubilizers for iodine. These agents are usually detergents to which iodine quickly binds. These complexes serve as reservoirs that release free iodine. An iodophor enhances the antimicrobial activity of the iodine present and reduces the vapor pressure, thus dramatically decreasing the offensive odors. Iodophor preparations are less irritating to tissues, cause significantly less allergies, and do not readily stain skin or clothing. They also have prolonged, or residual, biocidal activity after application. Iodophors have a broad spectrum of effectiveness, including bactericidal, tuberculocidal, and virucidal against hydrophilic and lipophilic viruses. Its biocidal activity is accomplished within 5 to 10 minutes of exposure. To ensure tuberculocidal activity, prepare fresh solutions daily; as iodophors lose effectiveness, the color changes from amber to clear. Iodophors become somewhat unstable at high temperatures and can have a rapid loss of antimicrobial activity when inactivated by hard water and alcohol. Distilled or at least softened water is recommended for diluting the iodophors prior to use. Iodophors are EPA-registered as intermediate level accepted as a surface disinfectant. They may *not* be used as a sterilant.

Iodophor antiseptics are useful in the preparation of oral mucosa for local anesthesia, surgical procedures, and handwashing. Not only does the iodophor remove the microbial populations from the skin but also a residual antimicrobial effect remains in the scrubbed areas. Although iodophors are used as both antiseptics and disinfectants, *the same product is never used for both.*

Chlorine compounds

As an intermediate-level disinfectant, chlorine acts primarily by oxidation, as hypochlorous acid, which it is converted into with water. As a result, chlorine is more active in acid solutions. The element chlorine is an effective germicide that kills most bacteria in 15 to 30 seconds at concentrations of 0.10 to 0.25 ppm. Accepted chlorine containing compounds commonly used are hypochlorite solutions and chlorine dioxide preparations.

Although sodium hypochlorite solutions have a rapid antimicrobial action and broad spectrum including bactericidal, tuberculocidal, and virucidal activities, it has several disadvantages. It is sporicidal only at high concentrations and because it is unstable, fresh solutions must be prepared daily. Its activity is diminished by organic matter or altered pH, and, therefore, cannot be reused. Other problems include irritation to the skin, mucous membrane and eyes, along with an unpleasant, persistent odor. Sodium hypochlorite will also corrode metals, damage clothing, and degrade plastic and rubber. The new CDC guidelines do *not* recommend household bleach for use in the dental environment.

Chlorine dioxide is an effective surface disinfectant or sterilant. It has a rapid action of 3 minutes for disinfection or 6 hours for sterilization. As with sodium hypochlorite, there are several disadvantages. Chlorine dioxide must be discarded daily, has a 24-hour use life as a sterilant, and does *not* readily penetrate organic debris. When chlorine dioxide is used for surface disinfection, it must be used with protective eyewear and gloves, closed containers, and adequate ventilation. In addition, it corrodes aluminum containers.

Phenolic compounds

Synthetic phenolics act in a synergistic manner when properly diluted with water creating a broad antimicrobial spectrum, including tuberculocidal activity. They also act as good surface cleaners and are effective in the presence of detergents. Synthetic phenolics are useful on metal, glass, rubber, and plastic, and are less toxic and corrosive than glutaraldehyde solutions. However, they create a film and accumulation, can degrade certain plastics, and etch glass with prolonged exposure. Synthetic phenolics are *not* sporicidal and must be prepared fresh daily. Another disadvantage of synthetic phenolics is the penetration properties tend to cause epithelial toxicity in exposed tissues. To prevent skin and eye irritation, protective gloves and eyewear must be worn during its use. Synthetic phenols are EPA-registered as an immersion disinfectant of heat sensitive instruments.

12. Barrier techniques

At times, adequate disinfection may not be possible or is too time consuming; therefore, another technique may be used. An effective approach to disease prevention is to reduce exposure to potentially dangerous microorganisms that may contaminate the body. A method, called *barrier techniques*, provides a physical barrier between the body and source of contamination. Barrier techniques include the use of PPE and surface covers. PPE, which we have previously covered, provides protection from contamination to the body with the use of masks, eyeglasses, and clothing. Surface covers prevent contamination of areas that are exposed to aerosols, spatter, or contaminated fingers during patient treatment. If not covered, these same areas would require adequate disinfection after treatment; otherwise they are sources of cross-contamination for the next patient.

Surface barriers should be fluid resistant such as plastic wrap or bags, aluminum foil; impervious backed paper may be used to protect surfaces against contamination by blood or OPIM. These surface covers can also be used on areas that are difficult to disinfect, such as light handles, dental control units, switches, headrests, bracket/instrument trays, 3-way syringe bases and controls, or x-ray tube heads. Using surface covers as a protective barrier has several advantages over disinfecting the surfaces. For the dental assistant, preparation and clean up of the dental treatment room is more efficient. Head rest covers, plastic wrap or bags, aluminum foil, or impervious backed paper can be placed on and removed from the surfaces easier and faster than adequate disinfection. They will also reduce the amount of cleaners and disinfectants otherwise used. Protective surface covers also

enhance the longevity of equipment due to reduced contact with corrosive, caustic, or staining compounds of disinfectants. The disadvantages of using surface covers are the increased cost of disposables and additional amount of solid wastes.

Remove and discard all surface coverings contacted during patient treatment while you are still gloved. It is important to remove the surface covers carefully to prevent contamination of the covered areas. This procedure is accomplished by turning the soiled outer side towards the inside, or inside-out. You must clean and disinfect the previously covered surfaces between patients only when the integrity of physical barriers has been compromised or when the surface is visibly soiled. For example, if moisture is absorbed through the cover to the underlying surface, then the purpose of the barrier is defeated, and the surface must be disinfected. After regloving, replace barriers before seating the next patient.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

008. Identification and cleaning

1. How can you establish an effective and efficient infection control routine in the short amount of time between patients?
2. What does cleaning involve, and why is it such an important step?
3. What areas require cleaning and when?
4. Why is it important to check the effectiveness of the DTR cleanliness from where the patient sits?

009. Principles of disinfection

1. Define disinfection.
2. What are the two methods of disinfection? What must be considered when choosing a method of disinfection?

3. Match the group of microorganisms in column B with the appropriate descriptions in column A. Column B items may be used more than once.

Column A

Column B

- | | |
|--|--|
| ____(1) Lowest level of resistance to disinfectant agents. | a. Vegetative bacteria. |
| ____(2) Most resistant forms of life known. | b. Nonlipid viruses. |
| ____(3) Impermeable waxy coating that gives a greatly increased resistance to many agents. | c. Tubercle bacillus. |
| ____(4) Most resistant microorganism after bacterial endospores. | d. Spores. |
| ____(5) Fourth most resistant to disinfectant agents. | e. <i>Mycobacterium tuberculosis</i> . |
| ____(6) Herpes simplex 1 and 2, influenza A ₂ , and HIV are in this group. | f. Fungi. |
| ____(7) Rotavirus (gastroenteritis) and poliovirus type 2 (polio are in this group). | g. Lipid viruses. |
| ____(8) Second lowest resistance to chemical disinfectants. | |
| ____(9) Third most resistant to disinfectants. | |

4. How may chemical disinfectants be used?
5. What must be considered when choosing disinfectants?
6. What is the term for an agent effective against vegetative bacterial cells, but not the more resistant bacteria, such as *Mycobacterium tuberculosis* or HBV? What agency regulates and registers these agents?
7. What is the term for agents that inhibit or suppress future bacterial growth but which do not actually destroy all bacteria present on the affected surface?
8. What is the term for chemical agents used to reduce the number of microorganisms on living tissues, such as in the oral cavity or on the hands? What agency regulates these products?
9. What is an essential preliminary step when disinfecting with chemicals? Explain the effects of this step.
10. What types of chemical agents can both clean and disinfect?
11. What items must you do prior to beginning disinfection procedures?

12. What determines the effectiveness of a chemical agent?
13. What are high-level disinfectants effective against?
14. What items must be treated by a high-level disinfectant?
15. What is the essential criterion for including a chemical in the high-level disinfectant class?
16. What are intermediate-level disinfectants effective against? What disinfectants are included in this level?
17. How should an intermediate-level disinfectant selected for use in dentistry be EPA-registered? What surfaces should be treated with an intermediate-level disinfectant?
18. What are low-level disinfectants effective against? What disinfectants are included in this group?

010. Selection and effectiveness factors of chemical disinfectants

1. How can the selection of appropriate immersion and surface disinfectants be simplified?
2. List 5 of the 10 criteria for an ideal disinfectant.
3. How must the EPA register a chemical agent used for disinfection in dentistry?
4. In addition to killing the three species of bacteria required of hospital disinfectants, what other requirements must disinfectants used in dentistry have?
5. What are the guidelines all chemicals selected for disinfection or sterilization in dentistry must meet to prove product effectiveness?

6. What is the purpose of the EPA number on the product label?
7. Why must a product be used according to the printed instructions on the label?
8. What does tuberculocidal action assure?
9. What is the effect if a chemical agent is diluted with alcohol rather than the water called for in the manufacturer's directions?
10. What can change the effect of the chemical agent when diluting?
11. What does exposure time depend on? What is the time specified by most disinfectant manufacturers for keeping surfaces wet after cleaning?
12. What effect does temperature have upon disinfectants?
13. What effect does pH have on disinfectants?
14. How can the amount of accumulated bioburden be controlled?
15. Briefly explain how the presence of organic matter or bioburden, such as pus, blood, saliva, or dental materials affects the efficiency of disinfectants.
16. Define each of the following terms: (a) shelf life, (b) use life, and (c) reuse life.
17. What is required for the chemical reaction of disinfection to take place?

011. Types of chemical agents

1. What must be done with instruments or other items before disinfecting?
2. Why must containers be kept covered? What information must labels on containers include? Why must solutions be changed frequently?
3. What types of disinfectants are listed as acceptable, intermediate hospital surface disinfectants by the EPA and ADA Council on Dental Therapeutics?
4. What are the problems inherent with the chemical actions of alcohols?
5. What are the advantages of iodophor preparations?
6. Why must fresh solutions of iodophors be prepared daily? What does a color change of amber to clear indicate?
7. What effect does temperature have on iodophors? How do hard water and alcohol affect iodophors? What is recommended to dilute iodophors prior to use?
8. What are the uses of iodophor antiseptics? Why are they useful in this manner?
9. What are the accepted chlorine containing compounds?
10. What are the advantages of sodium hypochlorite solutions?
11. What are the disadvantages of sodium hypochlorite?
12. What is chlorine dioxide effective as? What are the time requirements?

13. What are the disadvantages of chlorine dioxide?
14. How do synthetic phenolics act when properly diluted with water?
15. What are the disadvantages of synthetic phenolics?
16. What must be worn during the use of synthetic phenolics and why?

012. Barrier techniques

1. Define barrier techniques. What does it include?
2. What is the purpose of surface covers?
3. What items may be used as surface covers? Where are surface covers used?
4. What are the advantages of using surface covers as protective barriers?
5. What are the disadvantages of using surface covers?
6. Briefly describe how to remove the surface covers to prevent contamination.
7. When must you clean and disinfect the previously covered surfaces between patients?

Answers to Self-Test Questions**001**

1. Total or partial destruction of the many hundreds of microorganisms known to be pathological or possess pathological potential to produce disease.
2. To protect the health of all patients and employees, and to comply with applicable federal, state, and local regulations governing infection control, job safety, and management of regulated medical waste.

3. DECS; HQ USAF/SGWD.
4. Current Federal regulations including those issued by OSHA and EPA. The most current federal, state, local (including host country), and Air Force instructions take precedence over these guidelines whenever they are more stringent.
5. JCAHO, CDC, and ADA.
6. Dental squadron commander and dental infection control officer coordinate with the medical treatment facility infection control committee.
7.
 - (1) a.
 - (2) b.
 - (3) a.
 - (4) b.
 - (5) a.
 - (6) b.
 - (7) a.
 - (8) b.
 - (9) a.
8. DSC.
9.
 - (a) Health care associated infection reporting of those infections which were not present or incubating at the time the patient was treated in the clinic.
 - (b) Sterilizer monitoring program in which results of sterilizer testing must be documented and reported to the MTF infection control committee.
 - (c) Scheduled and unscheduled inspections routinely conducted and documented by dental infection control personnel to include dental treatment rooms, the dental laboratory, decontamination and sterilization areas, and locations where sterile items are stored.

002

1. Reasonably anticipated skin, mucosal, eye, or parenteral contact with blood OPIM, including saliva.
2. The *OSHA Bloodborne Pathogens Standard*.
3. Pathogenic microorganisms which are present in human blood and can cause disease in humans.
4. Using a combination of engineering and work practice controls, PPE, training, surveillance, hepatitis B vaccination, signs and labels, and other provisions.
5. Standard precautions.
6. OSHA. All MTFs are required to have a written exposure control plan that identifies all employees with occupational exposure, the procedure for evaluating exposure incidents, and a schedule for implementing the provisions of the rule. This document must be accessible to all employees, available to OSHA, and reviewed and updated at least annually.
7. The dental ICO. A determination as to whether there is actual or potential exposure to blood or OPIM involved in duty performance and identification of all individuals who work in areas where there is reasonably anticipated exposure to blood or OPIM.
8. Occupational exposure without regard to the use of personal protective clothing and equipment.
9. The dental ICO.
10.
 - (a) An accessible copy of the regulatory text of the standard and an explanation of its content.
 - (b) An explanation of the epidemiology and symptoms of blood-borne diseases.
 - (c) An explanation of the modes of transmission of blood-borne pathogens.
 - (d) An explanation of the written exposure control plan and how to obtain a copy.
 - (e) How to recognize occupational exposure.
 - (f) The methods to control occupational transmission of blood-borne pathogens.
 - (g) How to select, use, remove, handle, decontaminate, and dispose of personal protective clothing and equipment.

- (h) Information on the hepatitis B vaccine and vaccination, the availability of vaccine, and that vaccination is available at no cost to the personnel.
 - (i) Information on emergencies involving blood and other potentially infectious materials.
 - (j) An explanation of the reporting mechanisms for exposure incidents.
 - (k) Information on the post-exposure evaluation and followup available by a health care professional when an exposure incident occurs.
 - (l) An explanation of labels, signs, and other markings for contaminated materials, such as instruments and laundry.
 - (m) A question and answer session on any aspect of the training.
11. A specific eye, mouth, other mucous membrane, non-intact skin, or parenteral contact with blood or other potentially infectious material that results from the performance of an employee's duties. Report exposure incidents immediately to initiate a timely follow-up process by a health care professional and to initiate a prompt request for evaluation of the source individual's HBV and HIV status.
 12. A baseline blood test is drawn to establish the employee's HIV and HBV status. This allows the employee and employer to know if the employee was infected.
 13. Any patient whose blood or body fluids are the source of an exposure incident to the employee.
 14. Written consent.
 15. As soon as possible through consultation with the health care professional.
 16. The employer must provide a copy of the written opinion to the employee within 15 days of the evaluation.
 17. The hepatitis B vaccination status, including the dates of the hepatitis B vaccination and the written opinion of the health care professional regarding the hepatitis B vaccination. If an occupational exposure incident occurs, reports are added to the medical record to document the incident, and the results of testing following the incident, as well as the written opinion of the health care professional. The medical record must also indicate what documents have been provided to the health care provider.
 18. It may be kept on-site or retained by the health care professional who provides service to the dental health care employees.
 19. 30 years past the last date of employment of the employee.
 20. The employee or anyone having written consent of the employee; to representatives of the Secretary of Labor, upon request; or as required or permitted by State or Federal law.
 21. The base dental service for 3 years. Date of training, content outline, trainer's name and qualifications, names and job titles of all persons attending the training. Upon request, the Assistant Secretary of Labor, Occupational Safety and Health, and employees or employee representatives.

003

1. Sepsis means the presence of disease-producing microorganisms. Asepsis is the absence of all pathogenic microorganisms.
2. To break the chain of infection by eliminating the possibility of disease transmission.
3. 2 feet in front of the patient, where the dental health team is usually positioned.
4. By direct contact with infectious lesions, or infected saliva or blood, frequently through an open wound or lesion, such as a cut or hangnail.
5. Transfer of microorganisms from contaminated objects, such as instruments or needles.
6. It includes, but is not limited to, the following body fluids: semen, vaginal secretions, saliva in dental procedures, and any body fluids in situations where it is difficult or impossible to differentiate between body fluids.
7. The saliva may be mixed with blood in some dental procedures.
8. (a) Tiny, invisible particles of contaminated water, blood, saliva and respiratory secretions generated from the patient's mouth during dental procedures.
(b) During the use of handpieces, air-water syringe, ultrasonic scaler, prophylaxis-jet and toothbrushing.
9. Large droplets of saliva-borne microorganisms and debris, usually large enough to be visible, which can contaminate the air. It accumulates on surfaces in the immediate treatment area.
10. (a) Use of the rubber dam during operative procedures and at other times when practical.

- (b) Use of HVE during procedures involving the high-speed handpiece or when rinsing the mouth.
 - (c) Using the air-water syringe, apply water to the area, followed by air, rather than dispensing both at the same time to produce a forced spray of water.
 - (d) Limit the use of bristle brushes because these generate more spatters during polishing procedures than rubber cups or polishing points.
11. Having the patient rinse with water before dental treatment reduces the bacterial count approximately 75 percent, brushing the teeth by 90 percent, and using an antiseptic mouthwash before treatment by 98 percent.
 12. Microorganisms retracted up into the handpiece or water spray hose can be transmitted into the aerosols when these items are used. Daily flushing of water lines and installing anti-retraction valves will reduce but not eliminate microbial levels in the dental unit water supply.
 13. Sterilization. Disposable tips.
 14. Periodic testing must be performed by medical equipment repair personnel on a regularly scheduled basis.
 15. A dental unit equipped with a separate water reservoir.
 16.
 - (a) Use protective barriers to cover all countertops.
 - (b) Keep all clean and sterile supplies in closed containers, drawers, or cabinets.
 - (c) Disinfect all contaminated surfaces thoroughly between patients.
 17. Through the use of PPE.
 18. Observing proper patient-operator positioning, maintaining a safe operating distance from the patient's mouth, retracting soft tissues in ways that deflect liquid aerosols and spatter away from the health care personnel, and operating from behind the patient rather than in front.

004

1. Dental personnel, including civilian employees, volunteers, and dental laboratory personnel who perform tasks where there is exposure to blood and OPIM. Within 10 working days of initial assignment.
2.
 - (a) Without cost to the employee,
 - (b) At a reasonable time and place for the employee,
 - (c) By or under the supervision of a licensed health care professional with a copy of the blood-borne pathogens standard.
3. The health care professional.
4. To employees who have previously completed the vaccination series, when immunity is confirmed through antibody testing, or if the vaccine is contraindicated for medical reasons.
5. According to the current guidelines of the US Public Health Service, including recommendations made in the future for routine booster doses.
6. Medical histories and physical examinations cannot be relied upon to identify all patients infected with the viruses that cause hepatitis, AIDS, and other blood-borne pathogens.
7. All patients are potential carriers of infectious diseases. Dental personnel must assume that all body fluids, and contaminated instruments and materials are infectious and routinely use standard precautions to protect themselves and their patients.
8. All blood and OPIM must be considered equally infectious.
9. The potential risk of exposure to blood or OPIM posed by the procedure to be performed.
10. All patients are assumed to be infectious.
11. Patients who present with symptomatic infectious diseases transmissible by nonparenteral routes (e.g., influenza, streptococcal pharyngitis, recurrent herpes labialis).
12. To prevent the development of health care associated infections. Medical consultation in such cases is strongly recommended.

005

1. Controls applied to the DTR to isolate or remove the blood-borne pathogens hazard from healthcare personnel. Rubber dams, high-speed evacuators, and special containers for contaminated sharp instruments.
2. Controls which reduce the likelihood of exposure by altering the manner in which the task is performed.

3. Readjust the position of the dental chair.
4. Wash hands immediately, or as soon as feasible, after skin contact with blood or OPIM occurs and after removing gloves or other PPE.
5. Recapping, bending or removing contaminated needles from syringes is prohibited unless required by the dental or medical procedure. It must be done by mechanical means, such as the use of forceps, or using a one-handed technique.
6. Items are discarded into containers that are closable, puncture-resistant, leakproof, colored red, or labeled with the biohazard symbol. Containers must be easily accessible, maintained upright, mounted in a lockable fixture, and not allowed to overfill.
7. Labeling requires a fluorescent orange or orange-red label with the biological hazard symbol, along with the word *BIOHAZARD* in a contrasting color, affixed to the bag or container.
8. Place in containers that are puncture-resistant, leakproof, colored red, or labeled with the biohazard symbol until properly processed. Reusable sharps must not be stored or processed in such a way that employees are required to reach by hand into the container to retrieve the instruments.
9. Eating, drinking, smoking, applying cosmetics, and handling contact lenses.
10. Refrigerators, cabinets or shelves, and on countertops or benchtops where blood or OPIM are present.
11. In containers that are closed, prevent leakage, appropriately colored or affixed with the biohazard label.

006

1. Specialized clothing or equipment worn by personnel to protect themselves from exposure to blood or OPIM. Blood or OPIM to pass through to clothing, skin, or mucous membranes.
2. The task and reasonably anticipated degree of exposure to blood and OPIM during a given procedure.
3. Gloves, long-sleeved clinic smocks, or lab coats, and chin-length face shields with masks, or the combination of masks with eye protection.
4. All PPE must be removed.
5.
 - (1) Provide, maintain, and replace.
 - (2) Ensure accessibility in appropriate sizes.
 - (3) Provide hypo-allergenic gloves, glove liners, powderless gloves or other similar alternatives, if the employee has an allergy to the gloves usually provided.
 - (4) Ensure employee use.
 - (5) Launder reusable items and discard disposables.
6. When hand contact with blood, saliva, mucous membranes, or surfaces contaminated with body fluids or secretions is reasonably anticipated. When handling soiled or contaminated instruments, surfaces, or supplies. When handling contaminated materials such as impressions or prostheses.
7.
 - (a) Highest quality, most expensive, and best fitting; used for surgical or invasive procedures where maximum protection against infection must be provided for the patient and dental health team.
 - (b) Manufactured the same as sterile surgical gloves, but are nonsterile, not individually wrapped in pairs; sized the same as surgical gloves; packaged in a divided container with right-hand gloves on one side and left-hand on the other side; offer the highest quality and best fit at a greatly reduced cost when sterile surgical gloves are not required.
 - (c) Least expensive, nonsterile, commonly used in routine dental procedures; available in a variety of sizes.
 - (d) Latex-free, may be used for individuals who develop hypersensitive reactions to the latex material.
 - (e) May be worn over exam or surgical gloves during secondary procedures; not a replacement for wearing or changing latex gloves; removed before resuming the patient treatment that was in progress.
 - (f) Puncture-resistant; must be worn when handling and cleaning contaminated instruments; should also be worn when handling contaminated supplies and general treatment room cleaning; can be washed, disinfected or sterilized, and reused; must be discarded if they are deteriorated or fail to function as a barrier.
8. Reuse increases infection risks to dental personnel and to the patient. The present composition of the gloves does not permit them to be safely washed and reused.

9. Make them tacky and more prone to tear.
10. Immediately remove the gloves, wash your hands thoroughly, and replace damaged gloves before continuing the dental procedure.
11. Because of the potential for harboring microbes and causing holes in the gloves.
12. (1) Protection to the patient from contamination by a member of the dental health team who has a cold or similar condition transmitted by respiratory droplets.
(2) Protection for the dental health team from bacteria or virus-containing aerosols which may be generated during the procedure; and larger spatter particles of blood, saliva, and oral debris.
13. When procedures may generate aerosols and spatter. Outside patient treatment areas.
14. It should be discarded after each patient and a clean mask worn for each patient visit. If the mask becomes wet or visibly contaminated, it should be replaced sooner because it is no longer effective.
15. Physical injury from flying debris or accidental trauma, and infection from bacteria-laden aerosols.
16. Herpes simplex virus. Recurrent herpetic keratitis, which causes impaired vision and possible blindness.
17. The dental health team and patient must both wear protective eyewear when spatter or aerosols are likely to be created.
18. Glasses with solid, not perforated, side shields or goggles, which may fit over the regular corrective glasses.
19. Washed thoroughly with antiseptic soap and water, rinsed well, and disinfected with an intermediate level disinfectant that does not damage the glasses, or disposal of single-use protective eyewear.
20. Face masks. Completely disinfected.
21. Wearing freshly laundered clothing daily and changing sooner if the clothing becomes visibly soiled with blood or OPIM is important in the control of disease transmission.
22. The basic clothing ensemble selected for wear in dental treatment. The type and characteristics of the PPE depends upon the task and reasonably anticipated degree of exposure to blood and OPIM.
23. If clinical attire is not intended to function as protection against a hazard, it is not considered PPE and must be supplemented with PPE when exposure to blood or OPIM is reasonably anticipated.
24. During procedures where exposure to blood or OPIM is anticipated, unless the skin is protected by PPE.
25. The item must be laundered by the employer. When visibly soiled, or when worn without additional PPE for procedures where exposure to blood or OPIM has occurred.
26. Reusable or disposable gowns, or long-sleeved smocks.
27. When exposure to blood and OPIM in the form of spray, spatter, and aerosols is anticipated.
28. If it is anticipated that large amounts of blood, saliva, or other body fluids will soak through the gown.
29. If there is a potential contamination of shoes with blood or other potentially infectious materials.
30. (1) Ultrasonic scaling.
(2) Surgical procedures using rotary or ultrasonic instrumentation.
(3) Surgical procedures where unusually heavy bleeding may be anticipated.
(4) Manual decontamination of dental instruments where spatter or aerosols may be generated.
31. Immediately or as soon as feasible when penetrated by blood or other infectious materials. PPE is not permitted in eating areas or restrooms; and must be removed before leaving the work area to prevent contamination of others. Prevents the transfer of pathogens contacted during patient treatment to environments outside the dental setting, such as your car, home, family, and friends.

007

1. It keeps the level of skin bacteria to a minimum and reduces the build-up of skin bacteria that multiply under the gloves. Immediately, or as soon as feasible, wash your hands and any other skin with soap and water, or flush mucous membranes with water following contact with blood or OPIM; both before and after: going to lunch, taking a break, or using the bathroom; beginning and end of each duty day; immediately after the removal of personal protective equipment.
2. To prevent interference with patient comfort and tearing of disposable gloves, and allow effective instrument handling during intraoral procedures. The protected area under the nails is a potential source of cross-contamination because it harbors bacteria.
3. It harbors bacteria and may tear the gloves.

4. At the beginning of the duty day.
 - (1) Remove all jewelry and check for small cuts, abrasions, and hangnails.
 - (2) Clean fingernails with a plastic or wood stick under running water or by using a scrub brush.
 - (3) Scrub hands, nails, and forearms with a liquid antiseptic agent and sterile brush for 1 minute.
 - (4) Start from the fingertips down toward the elbow and rinse well with cool to lukewarm running water for 10 seconds or until all soap is removed.
 - (5) Lather hands again with the liquid antiseptic by rubbing for 10 to 20 seconds; repeat the rinsing procedure.
 - (6) Dry your hands starting with the fingers, then hands and last arms.
5. It enhances the destruction of bacteria rather than the bar soap which serves as a source for bacteria growth after use. To prevent cross-contamination of bacteria.
6. Parts of the thumb and areas of the finger tips.
7. You must scrub for a minimum of 2 minutes using multiple scrub and rinse cycles. Must also dry with sterile towels and don sterile gloves.
8. The use of an appropriate antiseptic hand cleanser in conjunction with clean cloth/paper towels or antiseptic towelettes; hands must be washed with soap and running water as soon as feasible.
9. Decontaminated with disinfectant upon completion of procedures; if protected with coverings, such as plastic wrap, foil, or imperviously-backed absorbent paper, these materials must be replaced after every patient and at the end of the workshift.
10. With a brush or tongs, but never picked up with hands, even if gloves are worn.
11. Must be decontaminated to the extent feasible or labeled as a biohazard indicating which parts were not able to be decontaminated.
12. (a) Liquid or semi-liquid blood or OPIM.
 (b) Items contaminated with blood or OPIM that would release these substances in a liquid or semi-liquid state if compressed.
 (c) Items caked with dried blood or OPIM and capable of releasing these materials during handling.
 (d) Contaminated sharps
 (e) Pathological and microbiological wastes containing blood or OPIM.
13. Any contaminated objects that can penetrate the skin including, but not limited to: needles, scalpels, broken glass, broken capillary tubes, and exposed ends of dental wires.
14. Must be disposed of immediately or as soon as feasible in containers that are closable, puncture resistant, leakproof, and are colored red or labeled *biohazard* and marked with the biohazard symbol.
15. (a) Must remain upright throughout use, be replaced routinely and not allowed to be overfilled.
 (c) When moving from the area of use, the containers must be closed immediately prior to removal or replacement to prevent spillage or protrusion of contents during handling, storage, transport, or shipping.
16. It must be contained in closable bags or containers that prevent leakage and colored red or labeled.
17. Any laundry soiled with blood or other potentially infectious materials, including saliva. All protective clothing and only contaminated clinical attire.
18. It may not be taken home to wash. Must be handled as little as possible and placed in bags or containers where it is used. Bags or containers must be either red or labeled with the biohazard symbol and word *Biohazard*, unless all personnel at the facility and off site laundry use standard precautions in the handling. If wet, the bags or containers must prevent leakage and soak-through.
19. Protective gloves and other appropriate PPE.

008

1. By restricting the numbers of surfaces that fall within the clinical contact category an effective and efficient infection control routine would be established for a short amount of time.
2. The physical removal of germ-laden dust and dirt from equipment and surfaces. The presence of excessive numbers of microorganisms, soil and organic matter, such as blood or saliva, can inhibit or even prevent methods of disinfection or sterilization from destroying the pathogens.

3. All surfaces in the DTR contacted by patients, providers, assistants, or dental aerosols require routine cleaning prior to placement of protective covers, disinfection, and sterilization.
4. Areas undetected from the provider's or assistant's view, may now be visible. Missed areas not only indicate inconsistencies or omissions in the cleaning routine but also affect the patient's opinion of the clinic's cleanliness. Patients may view these lapses in sanitization as a reflection of a general lack of concern not only for asepsis but also for their own health and well-being.

009

1. A process that kills disease-causing microorganisms with the exception of resistant bacterial spores.
2. Heat or chemical. Microorganisms targeted and composition of the article concerned.
3.
 - (1) a.
 - (2) d.
 - (3) c.
 - (4) e.
 - (5) f.
 - (6) g.
 - (7) b.
 - (8) g.
 - (9) b.
4. Immersion of small heat sensitive items or disinfection of surfaces in the DTR.
5. According to the range of bacteriostasis or bactericidal activity needed. Some destroy microorganisms while others only suppress growth and multiplication of microorganisms.
6. Germicide. EPA.
7. Bacteriostatic.
8. Antiseptics. FDA.
9. Cleaning or sanitizing. It reduces the number of bacteria and removes organic matter, such as blood and tissue, and other debris which may interfere with disinfection.
10. EPA registered surface disinfectants, such as iodophors, synthetic phenolics, and chlorine compounds.
11. Gloves, face mask, and eye protection.
12. The type and resistance of microorganisms.
13. All vegetative bacteria, fungi, and viruses, including the tubercle bacillus, bacterial spores, and viruses similar to the hepatitis virus.
14. Any item that cannot undergo sterilization.
15. The ability to kill bacterial spores.
16. All microorganisms, except for bacterial spores. Chlorine compounds, iodophors, and phenolic disinfectants.
17. As a tuberculocidal, hospital disinfectant, with appropriate virucidal activity. All surfaces which are not covered with a protective barrier should be treated.
18. Against vegetative bacteria and some viruses. Quaternary ammonium compounds, simple phenolics and detergents. Only on noncritical items.

010

1. By comparing the effectiveness of the available agents with the criteria for an ideal disinfectant.
2.
 - (1) Widest possible antimicrobial spectrum.
 - (2) Rapid lethal action on all vegetative forms and spores of bacteria and fungi.
 - (3) Residual effect on treated surfaces that becomes reactivated when surfaces are moistened.
 - (4) Active in the presence of bioburden, such as blood, saliva, and feces.
 - (5) Compatible with soaps, detergents, and other chemicals encountered in use.
 - (6) Noncorrosive to instruments and other metal surfaces.
 - (7) Does not cause disintegration of cloth, rubber, plastics or other materials.

- (8) Odorless to permit routine use.
- (9) Easy to use.
- (10) Economical cost.
3. As a hospital disinfectant.
4. Must be tuberculocidal and virucidal for lipid and nonlipid viruses.
5. (a) Product must display an EPA number on the label.
(b) Must be used in strict compliance with the printed instructions on the label.
(c) Product should state on the label that it kills *Mycobacterium tuberculosis*.
6. Proof of the product's registration with the EPA in compliance with federal law. Proves that the product performs as the manufacturer claims. Provides reasonable legal protection for the user that only products in compliance with the Federal law are used in patient treatment.
7. Chemical and microbiological considerations require use of the product in a disciplined manner to assure the product effectiveness as stated by the manufacturer. Ignoring instructions nearly always reduces microbial control.
8. The product is an intermediate- or higher-level disinfectant and will destroy all pathogens potentially threatening to dentistry.
9. The cleaning ability of the active agent will be impaired and the alcohol may actually increase the harmful effects of some disinfectants, such as iodophors.
10. Haphazardly estimating the amount of disinfectant agent and water may cause the solution to be ineffective. The presence of hard water interferes with the effect of certain disinfectants.
11. Materials to be disinfected, the quantity, number and type of organisms, and concentration and rapidity of penetration of the germicide. Usually 10 minutes.
12. A warm solution is likely to be more effective than a cold one because heat lowers surface tension and increases the speed of chemical reactions in disinfection.
13. Some disinfectants are more active in acid, others in alkaline environments. Deviation from the desired pH directly alters the effectiveness of the disinfectant.
14. By precleaning items and surfaces prior to disinfecting.
15. Chemicals can coagulate and combine with proteins and produce barriers or films about the microorganisms that inhibit penetration of the disinfectant into the bacterial cells. All the active ingredients of the solution may become involved with the organic coating so that none will be available to kill the microorganisms.
16. (a) The time that an agent may be safely stored.
(b) Life expectancy for the solution once it is activated, but not actually used with contaminated items.
(c) Amount of time a solution can be used and reused once wet or bioburdened instruments or items are used in the agent.
17. Adequate exposure of the entire surface of the item to the chemical.

011

1. Cleaned first, then rinsed and drained thoroughly before placing in the solution.
2. (a) To prevent particles from settling on the solution, evaporation of solution, and environmental hazards from emitted fumes.
(b) Expiration date, name, and dilution of the agent.
(c) To maintain proper concentrations, reduce amount of bioburden, and the possibilities of cross-contamination.
3. Iodophors, synthetic phenolics, and chlorine-containing compounds.
4. (a) Not effective in the presence of tissue proteins, such as those found in saliva and blood because they tend to inactivate the alcohol.
(b) Poor cleaning agents in the presence of bioburden.
(c) Rapid evaporation rate reduces its activity against viruses in dried blood and saliva commonly found in the spatter created during dental procedures.

- (d) Lack of sporicidal activity, corrosiveness on metals, and damages rubber and plastics.
- 5. (a) Less irritating to tissues, cause significantly less allergies, and do not readily stain skin or clothing.
(b) Prolonged or residual, biocidal activity after application.
(c) Broad spectrum of effectiveness including bactericidal, tuberculocidal, and virucidal against hydrophilic and lipophilic viruses.
(d) Biocidal activity is accomplished within 5 to 10 minutes of exposure.
- 6. To ensure tuberculocidal activity. Loss of effectiveness.
- 7. Somewhat unstable at high temperatures. A rapid loss of antimicrobial activity when inactivated by hard water and alcohol. Distilled or at least softened water.
- 8. Preparation of oral mucosa for local anesthesia, surgical procedures, and handwashing. Removes the microbial populations from the skin, and a residual antimicrobial effect remains in the scrubbed areas.
- 9. Hypochlorite solutions and chlorine dioxide preparations.
- 10. Rapid antimicrobial action and broad spectrum including bactericidal, tuberculocidal, and virucidal activities.
- 11. Sporicidal only at high concentrations. Because it is unstable, fresh solutions must be prepared daily. Activity diminished by organic matter or altered pH, and therefore, cannot be reused. Irritation to the skin, mucous membrane and eyes, along with an unpleasant, persistent odor. Corrodes metals, damages clothing, and degrades plastic and rubber.
- 12. Surface disinfectant or sterilant. 3 minutes for disinfection or 6 hours for sterilization.
- 13. Must be discarded daily, 24-hour use life as a sterilant. Does not readily penetrate organic debris. Must be used with protective eyewear and gloves, closed containers, and adequate ventilation when used for surface disinfection. Corrodes aluminum containers.
- 14. In a synergistic manner, creating a broad antimicrobial spectrum including tuberculocidal activity.
- 15. Create a film and accumulation. Can degrade certain plastics, and etch glass with prolonged exposure. Not sporicidal. Must be prepared fresh daily. Penetration properties tend to cause epithelial toxicity in exposed tissues.
- 16. (a) Protective gloves and eyewear must be worn during its use.
(b) To prevent skin and eye irritation.

012

- 1. A method that provides a physical barrier between the body and source of contamination. The use of PPE and surface covers.
- 2. To prevent contamination of areas that are exposed to aerosols, spatter, or contaminated fingers during patient treatment.
- 3. Plastic wrap or bags, aluminum foil, or impervious backed paper. Surfaces that would be contaminated by blood or OPIM, and areas that are difficult to disinfect, such as light handles, dental control units, switches, headrests, bracket/instrument trays, 3-way syringe bases and controls, or x-ray tube heads.
- 4. (a) Preparation and clean up of the dental treatment room is accomplished with greater efficiency.
(b) Surface covers can be placed and removed on the surfaces easier and faster than disinfecting adequately.
(c) Reduce the amount of cleaners and disinfectants otherwise used.
(d) Enhance the longevity of equipment due to reduced contact with corrosive, caustic, or staining compounds of disinfectants.
- 5. Increased cost of disposables and additional amount of solid wastes.
- 6. Remove and discard all surface coverings contacted during patient treatment while you are still gloved. Turn the soiled outer side towards the inside, or inside-out.
- 7. Only when the integrity of physical barriers is compromised or when the surface is visibly soiled.

Do the unit review exercises before going to the next unit.

Unit Review Exercises

Note to Student: Consider all choices carefully, select the *best* answer to each question, and *circle* the corresponding letter. When you have completed all unit review exercises, transfer your answers to the Field Scoring Answer Sheet.

Do not return your answer sheet to the Extension Course Program (A4L).

1. (001) Who appoints the Special Consultant for Infection Control?
 - a. USAF Surgeon General.
 - b. USAF Surgeon General for Dental Services.
 - c. USAF Assistant Surgeon General for Dental Services.
 - d. MAJCOM Assistant Surgeon General for Dental Services.
2. (001) Who develops and publishes guidelines for the USAF Dental Infection Control Program?
 - a. Dental Infection Control Officer.
 - b. Special Consultant for Infection Control.
 - c. USAF Assistant Surgeon General for Dental Services.
 - d. MAJCOM Assistant Surgeon General for Dental Services.
3. (002) The *Occupational Safety and Health Administration (OSHA) Bloodborne Pathogens Standard* is
 - a. a state law that sets forth specific requirements to prevent the transmission of bloodborne diseases to employees.
 - b. a Federal rule that sets forth specific requirements to prevent the transmission of bloodborne diseases to patients.
 - c. an Air Force regulation that sets forth specific requirements to prevent the transmission of bloodborne diseases to patients and employees.
 - d. a Federal rule that sets forth specific requirements to prevent the transmission of bloodborne diseases to employees.
4. (002) When *must* the exposure-control plan be reviewed and updated, and who should have access to the plan?
 - a. Quarterly; employees only.
 - b. Quarterly; supervisors and OSHA.
 - c. At least annually; all employees and OSHA.
 - d. At least semiannually; all employees and OSHA.
5. (002) The *minimum* requirements of the training program on controlling occupational exposure to bloodborne pathogens in dentistry are determined by
 - a. OSHA.
 - b. bioenvironmental engineering.
 - c. the dental squadron commander.
 - d. the dental infection control officer.
6. (002) Following the post-exposure evaluation, how many days does the employer have to provide the employee with a copy of the health care professional's written opinion?
 - a. 7.
 - b. 15.
 - c. 30.
 - d. It is not required.

7. (002) How many years does Occupational Safety and Health Administration (OSHA) require medical records be maintained on employees with occupational exposure, and from what date of employment is this based?
 - a. 10; the last date.
 - b. 20; the initial date.
 - c. 30; the initial date.
 - d. 30; last date.
8. (002) Training and medical records *must* be made available to
 - a. employees only.
 - b. Assistant Secretary of Labor, Occupational Safety and Health Administration only.
 - c. employees and the Assistant Secretary of Labor, Occupational Safety and Health Administration.
 - d. employees, supervisors, commanders, and Assistant Secretary of Labor, Occupational Safety and Health Administration.
9. (003) Droplets of saliva-borne microorganisms and debris that are usually large enough to be visible are known as
 - a. over-spray.
 - b. aerosols.
 - c. splatter.
 - d. spatter.
10. (003) Having the patient use an antiseptic mouthwash *before* treatment can reduce the bacterial count by what percent?
 - a. 50.
 - b. 75.
 - c. 90.
 - d. 98.
11. (003) Microbial levels in the dental unit water supply may be reduced by flushing the water/air lines for
 - a. 20–30 seconds between patients.
 - b. 3 minutes at the beginning of the clinical day.
 - c. 20–30 seconds between patients and 3 minutes at the end of the clinical day.
 - d. 3 minutes at the beginning of the clinical day and 30–40 seconds between patients.
12. (004) Occupational Safety and Health Administration (OSHA) requires that a hepatitis B vaccination be made available to every employee whose job classification or tasks result in occupational exposure within how many days of initial assignment?
 - a. 10 working days.
 - b. 10 calendar days.
 - c. 30 working days.
 - d. 30 calendar days.
13. (004) The hepatitis B vaccination series *must* be administered according to the current guidelines
 - a. of the US Public Health Service.
 - b. of the Food and Drug Administration.
 - c. and future routine booster dose recommendations of the US Public Health Service.
 - d. and future routine booster dose recommendations of the Food and Drug Administration.

14. (004) The application of standards of infection control based on the assumption that all patients are potential carriers of infectious diseases *best* describes
 - a. low risk protocol.
 - b. high risk protocol.
 - c. carrier precautions.
 - d. standard precautions.
15. (005) What type of controls applied to the dental treatment room isolates or removes the bloodborne pathogens hazard from healthcare workers?
 - a. Exposure.
 - b. Work place.
 - c. Engineering.
 - d. Work practice.
16. (005) What types of controls reduce the likelihood of exposure by altering the manner in which the task is performed?
 - a. Work practice.
 - b. Engineering.
 - c. Work place.
 - d. Exposure.
17. (006) Gloves are required to be worn
 - a. only when handling soiled instruments, surfaces, supplies, or materials.
 - b. only when hand contact with blood and saliva is reasonably anticipated.
 - c. when hand contact with blood, saliva, or unsoiled materials (such as impression tray) is *not* reasonably anticipated.
 - d. when hand contact with blood, saliva, mucous membranes or surfaces contaminated with body fluids or secretions *is reasonably anticipated*.
18. (006) Who *must* wear protective eyewear when spatter or aerosols are likely to be created?
 - a. Dental health team.
 - b. Provider and patient.
 - c. Assistant and patient.
 - d. Dental health team and patient.
19. (006) The Occupational Safety and Health Act (OSH Act) requires the employer to launder general work clothes
 - a. at the employee's request.
 - b. when worn without personal protection equipment (PPE).
 - c. when exposure to blood or other potentially infectious material (OPIM) *is reasonably anticipated*.
 - d. when visibly soiled with blood or OPIM, or when worn without additional PPE for procedures where exposure to blood or OPIM occurred.
20. (006) What type of clothing *must* be worn during ultrasonic scaling procedures or manual decontamination of dental instruments where spatter or aerosols may be generated?
 - a. Head and shoe covers.
 - b. Fluid resistant gowns and head covers.
 - c. Long-sleeved clothing or gowns and head covers.
 - d. Long-sleeved clothing or gowns in combination with head and shoe covers.

21. (007) What *must* be done *before* equipment that has had contact with blood or other potentially infectious material (OPIM) is serviced on-site or shipped out of the facility?
 - a. Decontaminate it to the extent feasible or label as a biohazard, indicating which parts could not be decontaminated.
 - b. Nothing; decontamination is the responsibility of the service or maintenance technician.
 - c. Decontamination is *not* required if the biohazard symbol is placed on it.
 - d. Decontaminate and place a biohazard label on the equipment.
22. (007) How *must* contaminated disposable sharps be discarded?
 - a. All needles must be destroyed immediately and placed in plastic containers, along with other contaminated sharps.
 - b. All items must be disposed of immediately, or as soon as feasible, in leak proof containers which are labeled —Biohazard‖ and marked with the biohazard symbol.
 - c. All items must be disposed of immediately, or as soon as feasible, in puncture resistant, leak proof containers which are colored red or labeled —Biohazard‖ and marked with the biohazard symbol.
 - d. All items must be disposed of immediately, or as soon as feasible, in closable, puncture resistant, leak proof containers which are colored red or labeled —Biohazard‖ and marked with the biohazard symbol.
23. (007) What items are considered as *contaminated laundry*?
 - a. Soiled protective clothing.
 - b. Contaminated clinical attire.
 - c. All protective clothing and clinical attire.
 - d. All protective clothing and only contaminated clinical attire.
24. (008) The *environmental surfaces* can be divided into how many surfaces?
 - a. One.
 - b. Two.
 - c. Three.
 - d. Four.
25. (008) What is the *first* step in creating a safe treatment environment?
 - a. Cleaning.
 - b. Disinfection.
 - c. Sterilization.
 - d. Placing protective covers.
26. (009) What level of microorganisms has the *lowest resistance level* to *disinfecting agents*?
 - a. Vegetative bacteria.
 - b. Tubercle bacillus.
 - c. Lipid viruses.
 - d. Spores.
27. (009) What is the *most resistant* form of life known?
 - a. Bacterial endospores.
 - b. Vegetative bacteria.
 - c. Lipid viruses.
 - d. Fungi.
28. (009) Which of the following is *not* a *chemical disinfectant level*?
 - a. Low.
 - b. High.
 - c. Moderate.
 - d. Intermediate.

-
-
29. (009) Agents which inhibit or suppress future bacterial growth but do *not* actually destroy all bacteria present on the affected surface are termed
- bacteriostatics.
 - bactericides.
 - germicides.
 - viricides.
30. (009) High-level disinfectants are effective against viruses similar to the hepatitis virus,
- vegetative bacteria, fungi, tubercle bacillus, and bacterial spores.
 - fungi, tubercle bacillus, and bacterial spores.
 - vegetative bacteria, and bacterial spores.
 - tubercle bacillus and vegetative bacteria.
31. (009) What level of disinfectant is used on *semicritical surfaces* that are *not* covered with a protective barrier?
- Intermediate.
 - Secondary.
 - High.
 - Low.
32. (009) Other than detergents, the disinfectants included in the low-level group are quaternary ammonium compounds,
- and simple phenolics.
 - phenolics and alcohols.
 - alcohols, and simple phenolics.
 - and synthetic phenolic compounds.
33. (010) Which of the following is *not* a property of an *ideal disinfectant*?
- The widest possible antimicrobial spectrum.
 - A rapid lethal action on all vegetative forms and spores of bacteria and fungi.
 - A residual effect on treated surfaces that is activated when surfaces are dry.
 - An effect active in the presence of bioburden such as blood, saliva, and feces.
34. (010) When chemicals coagulate and combine with proteins and produce barriers or films about the microorganisms that inhibit penetration of the disinfectant into the bacterial cells is the *best* description of which *effectiveness factor*?
- pH.
 - Expiration.
 - Temperature.
 - Organic matter.
35. (010) Which of the following takes into account a *dilution factor* caused by added water from wet instruments, effects of soap and other detergents, and evaporation?
- Use life.
 - Shelf life.
 - Reuse life.
 - Expiration date.
36. (011) Which of the following are currently listed by the Environmental Protection Agency (EPA) and the American Dental Association (ADA) Council on Dental Therapeutics as *acceptable intermediate hospital-surface disinfectants*?
- Alcohols, iodophors, and synthetic phenolics.
 - Only synthetic phenolics and chlorine-containing compounds.
 - Iodophors, synthetic phenolics, and chlorine-containing compounds.
 - Alcohols, iodophors, synthetic phenolics, and chlorine-containing compounds.

37. (011) Which fluid is recommended to *dilute iodophors prior to use*?
- a. Alcohol.
 - b. Tap water.
 - c. Sterile water.
 - d. Distilled or softened water.
38. (011) When properly diluted with water which chemical agents act in a synergistic manner to create a broad antimicrobial spectrum including *tuberculocidal* activity?
- a. Alcohols.
 - b. Iodophors.
 - c. Synthetic phenolics.
 - d. Sodium hypochlorite and chlorine dioxide.
39. (011) Which chemical agents are *not* considered effective in the presence of tissue proteins?
- a. Alcohols.
 - b. Iodophors.
 - c. Chlorine compounds.
 - d. Phenolic compounds.
40. (012) When *must* you clean and disinfect previously covered surfaces between patients?
- a. Only when the integrity of the physical barriers are compromised or when the surface is visibly soiled.
 - b. Each time the physical barriers are removed.
 - c. After each patient treatment is completed.
 - d. Only when the surface is visibly soiled.

Unit 2. Infection Control 2: Sterilization, and Clinical, Radiology, and Laboratory

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ONE OF YOUR most important responsibilities as a dental technician is to process contaminated instruments and other patient care items for reuse. Proper instrument processing is necessary in order to prevent transferring microorganisms from a previous patient to the next patient or to yourself. You are legally and ethically responsible for performing the procedures described in this unit in a thorough and careful manner.

2–1. Sterilization

The highest level of contamination control is *sterilization* because it results in the total destruction of all forms of microbial life. There are several approved methods of sterilization, including steam under pressure, dry heat, unsaturated chemical vapor, and ethylene oxide. Because of the different composition of many items used in dentistry, no single sterilization method is suitable for all dental items. Therefore, you need to know about several of the approved methods. In this section we'll cover the different types of sterilization, monitoring, and conclude with a lesson on instrument processing.

13. Principles and types of sterilization

Sterilization is the process by which all forms of life are completely destroyed. This includes all forms of microbial life, such as bacteria, fungi, viruses, and bacterial spores. Sterile is an absolute term.

Principles of sterilization

There is no such thing as partially sterile or almost sterile. Infection control standards call for sterilization of all instruments that will penetrate, or are likely to penetrate, soft tissue. This includes:

- Surgical instruments.
- Rubber dam clamps.
- Scalars.
- Scalpels.
- Periodontal probes.
- Matrix retainers.

Heat sterilization methods currently accepted in USAF dental clinics include steam under pressure (autoclave—either gravity displacement or prevacuum), dry-heat, and unsaturated chemical vapor. Ethylene oxide sterilization is acceptable when available through the medical treatment facility's (MTF) Central Sterile Supply (CSS).

The sterilization method must be compatible with the items to be sterilized. Some items that tolerate steam under pressure may be damaged by dry heat. Sterilization wraps, adhesives, and containers must also be compatible with the sterilization method. Instruments which are hinged or complex must

be opened or disassembled in order to permit exposure to sterilizing agents. All packs or rigid containers must be labeled with the sterilizer identification number, initials of the person who wrapped the pack, load number, and the expiration date. An internal chemical indicator should also be used. If the internal indicator cannot be seen from outside the pack, then use an external indicator as well. Arrange packs or containers loosely in the sterilizer chamber. Overloading the chamber prevents achieving sterilization evenly throughout the load.

Regardless of the sterilization method, follow the manufacturer's instructions for using the sterilization equipment. The manufacturers make recommendations for appropriate cycle lengths and other operating parameters. Post copies of operating procedures or make them readily available in all areas where sterilization is done. In addition, perform scheduled maintenance and calibration of sterilization equipment according to the manufacturer's recommendations. To ensure proper function of the sterilizing equipment, conduct biological spore monitoring at least weekly.

Steam under pressure

The steam-under-pressure method is also known as ~~–~~saturated-steam sterilization. Moist heat, in the form of steam under pressure, is one of the most effective and practical methods for sterilizing dental instruments. During the heating process, bubbles rise through the water, break at the surface, and release steam into the space above the water surface. The steam in this space is known as saturated steam. When an article is placed in a steam sterilizer, it absorbs heat as the saturated steam condenses. This transfer of heat to an article by condensation is the basis of steam-under-pressure sterilization. This process continues until the object being sterilized reaches the same temperature as the surrounding steam. At this point condensation stops, and no further heat transfer occurs. For unwrapped metal instruments, this process takes a relatively short time because the steam is in direct contact with the metal; but for large linen packs the process takes considerably longer. When a pack is sterilized, each successive layer must be penetrated by saturated steam and heated as the steam condenses on the cool material. This process continues until all areas of the pack have been heated to the same temperature as the surrounding steam. Once the sterilization cycle is complete, the items must dry completely before removing them in order to maintain sterility.

To effectively sterilize items using saturated steam, the temperature of the steam throughout the load must be high enough to destroy the most resistant microorganisms in the time allotted for sterilization. For example, some spores can withstand temperatures above the normal boiling point of water (212°F or 100°C); so the relationship of temperature to spore-killing power is critical. Steam temperature and exposure time, *not pressure*, are the crucial components of this process. Pressure is used only to raise the temperature of the steam and, in itself, has nothing to do with microbial killing action. At 15 psi, the boiling point increases to 121°C (250°F), a temperature at which all known organisms are killed.

In addition to the high temperature, steam must be saturated so that it will quickly release heat through condensation when it comes into contact with a cool object. The steam must be free of air that forms cool air pockets, which reduce the heating and penetrating power in the sterilizer. Sterilization will not occur unless all air is eliminated from the chamber at the beginning of the process and periodically throughout the sterilization cycle. Even small amounts of air prevent sterilization. The steam must have free access to all items in the sterilizer. The packaging of supplies and loading of the sterilizer must be done so that the steam comes into contact with all areas or surfaces of the items being sterilized.

Flash sterilization is defined as the sterilization of unwrapped items in a gravity displacement or prevacuum sterilizer with recommended minimum exposure times and temperatures. Steam sterilization by this unwrapped method is *not recommended*. It should be used only for emergency sterilization.

Steam under pressure may be used for any objects not damaged by moisture or high temperatures. Stainless steel instruments may be autoclaved along with those made of carbon steel; however, it may dull the cutting edges.

A steam sterilizer, also known as an autoclave, is a pressure-type vessel with a door or cover, valves to control the entry and exit of steam and air, and monitoring devices to allow the operator to observe conditions inside. It is designed to hold items and allow steam under pressure to penetrate these items. Steam sterilizers are available in many sizes, ranging from portable countertop to the fixed room-size sterilizer shown in figure 2-1.

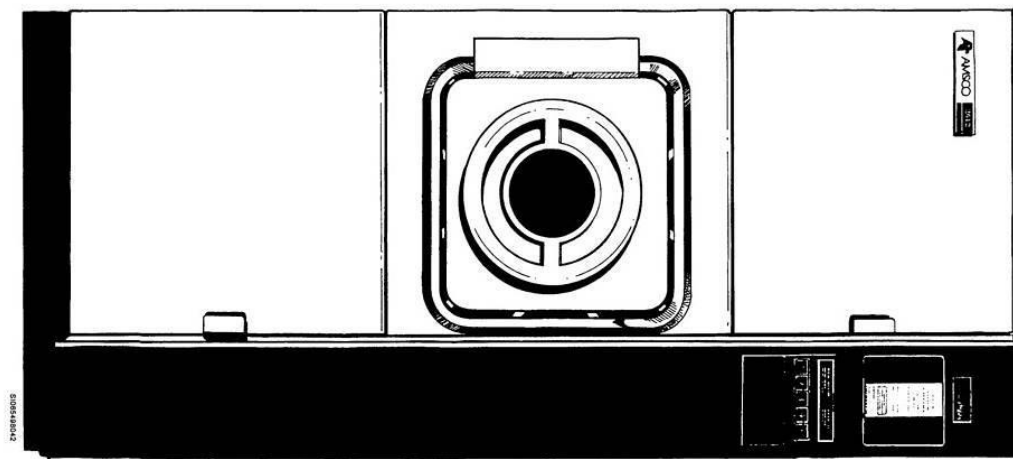


Figure 2-1. Floor-mounted steam sterilizer.

Newer models of these sterilizers feature an advanced microcomputer control system providing the latest standard for cycle setup, selection, and monitoring. Once settings are made and the cycle starts, microcomputers accurately monitor and control the system operations. Most new models provide an easy-to-read, printed record of all pertinent cycle data (fig. 2-2).

The record permits the operator to easily verify that the cycle parameters are met. Computer generated printouts include:

- Date.
- Sterilizer number.
- Daily cycle number.
- Starting time of cycle.
- Temperature selected.
- Key transition points in the cycle.
- Any deviations which might jeopardize the sterilization process.

Proper care of steam sterilizers

Clean the interior of the steam sterilizer regularly in order to maintain proper functioning. This simple procedure is easily done by using a mild detergent to wash the surfaces. Follow the wash with a thorough rinse with plain water. Unless this



Figure 2-2. Printout of the cycle data.

is done, the chamber walls will collect mineral deposits and may become greasy. Do *not* use wire brushes, steel wool, or any type of abrasive cleaning compounds on the sterilizers. Follow the manufacturer's directions for maintaining a properly functioning sterilizer. If the sterilizer does not appear to function properly, have medical equipment repair personnel check it at once. Spot-check sterilizers frequently for leaks in lines and improperly functioning gauges, dials, thermometers, doors, drain strainers, and valves.

Types of steam sterilizers

There are several types of steam sterilizers widely used: the gravity displacement sterilizer, prevacuum high-temperature (steam) sterilizer, and instrument washer sterilizer. We'll look at each of these in more detail in the following paragraphs.

Gravity displacement

Once this sterilizer is loaded and the door is closed, steam is admitted through an inlet. As the steam enters, air is evacuated downward and out of the chamber through a chamber discharge line. This process is rapid when the sterilizer is empty, but when it is filled with supplies, air may be trapped around and, more frequently, inside the supplies, keeping the steam from contacting all portions of the items and preventing sterilization in that area. When the air stops flowing through the outlet, the outlet is closed by a thermostatic valve. After enough time has elapsed for the steam to penetrate the center of items and sterilization to occur, the steam is exhausted through the outlet valve. Consult the manufacturer's instructions for the details of required user maintenance.

There are several precautions to take when loading the sterilizer chamber. Do not overload. Do *not* block the passage of steam from the top of the chamber to the bottom. Place all packages on edge, with large packs at the bottom of the chamber, and small packages in an upper layer crosswise to lower layer. This allows the free passage of steam. If mixed loads of metal items and linen are sterilized together, the linen is placed on the upper shelf and the metal items on the lower. Sterilize articles that require the same amount of time and the same final steps together. Fluids are sterilized separately because the pressure must be slowly released. Never put supplies in a heated sterilizer until it is time for the sterilization process to start. Supplies exposed to such heat before sterilization causes fabrics to dry, superheat, and incur damage during sterilization.

Prepare and post for easy daily reference a standard chart for the correct exposure period of all supplies. It is important to note that sterilizing conditions are based on temperature rather than on pressure. Effective steam sterilization and time of exposure are measured from the moment the thermometer in the discharge line indicates the desired preset temperature. The pressure inside the sterilizer is *not* an indication of positive sterilization because air elimination and other factors determine the pressure inside the sterilizer. Pressure merely maintains temperature. Additionally, the pressure required to maintain a sterilizing temperature will vary according to altitude. As recommended standard for USAF dental clinics, steam sterilization is complete at 250°F or 121°C after 20 to 30 minutes at 15 psi. It is important to refer to the manufacturer's directions, since exposure times can vary according to the sterilizer's design.

Prevacuum high-temperature

The prevacuum high temperature steam sterilizer is designed to overcome the problems of improper packaging and overloaded sterilizers. One of the greatest dangers encountered when using saturated steam under pressure is air trapped inside the sterilizing chamber. Cool air pockets form when improperly packaging items or overloading the sterilizer chamber occurs. This results in items not being sterilized. The speed and efficiency of the steam sterilizer may be improved by removing air from the chamber with a powerful pump, creating a nearly perfect vacuum before steam is introduced into the chamber. This procedure allows faster and more positive heat penetration of the entire sterilizer load. This improved sterilizer is referred to as the prevacuum steam sterilizer.

The cycles of the prevacuum sterilizer are short because the system initially removes air from the chamber via a vacuum pump. The cycle varies with the size of the sterilizer, the adequacy of steam,

and the supply of water. The prevacuum sterilizer achieves full heating of the loads faster than the gravity displacement steam sterilizer. For example, wrapped instruments are sterilized at 270°F (131°C) after 4 minutes exposure in a prevacuum steam sterilizer. Consult the manufacturer's instructions for specific details and user maintenance information.

The Bowie-Dick or air removal test was developed for prevacuum sterilizers to determine if the air has been removed from the chamber during the prevacuum stage. Air must be removed so that steam can penetrate the load instantaneously. It must be understood that this is *not* a test for adequate exposure to heat in terms of time-at-temperature. Commercially prepared Bowie-Dick tests can be used by carefully reading and following the manufacturer's instructions. Placing autoclave tape on the surface of a fabric can also carry out the test. Usually, three or four pieces of tape are placed on the fabric in a crisscross manner. The fabric layer is arranged in a test pack in a manner that allows the tape strips to extend from the edge to the center of the pack at a given layer depth. Conduct the test after a warm-up cycle is completed. Place the test pack in the bottom front of an otherwise empty chamber. After exposure in the prevacuum sterilizer, open the test pack, and check the tape. The tape shows by its color change the pattern of residual air, if any, that remained in the pack during the sterilization cycle. The uniformity of the color change, not the intensity, is the significant factor. If the test indicates inadequate air removal, notify medical equipment repair personnel, to repair the sterilizer before using the prevacuum cycle.

Washer-sterilizer

Washer-sterilizers are commonly used in medical CSS and dental clinics to decontaminate instruments. Instruments used in patient care are placed in rigid, reusable container systems, such as cassettes or baskets. The cassettes or baskets are loaded into the washer-sterilizer, which cleans the objects with mechanically agitated water and detergent, much like a dishwasher. The cycle consists of a washing process (series cleaning and rinsing), and sterilization at temperatures as high as 270°F. The time, temperature, and exact phases of the washer-sterilizer cycle vary with newer models. Consult the manufacturer's instructions for specific details and user-maintenance information.

Once the cycle is completed, the instruments are terminally sterilized. *Terminal sterilization* refers to the sterilization process of items immediately after use in patient care, but before further processing. Since the instruments are processed through the washer-sterilizer before technician handling, the risk of injury from contaminated instruments during processing is greatly reduced.

After terminal sterilization, the instruments are inspected and prepared for final sterilization. Final sterilization is processing items after terminal sterilization and is accomplished after assembling and wrapping of packs or trays.

Dry heat sterilizer

Dry heat is the least expensive form of heat sterilizing instruments. Dry heat destruction of microorganisms in a dental facility requires a commercial sterilizer unit that has been tested and approved by the FDA. A complete sterilization cycle involves heating the oven to the appropriate temperature and maintaining that temperature for the proper interval. Because dry air is not as efficient a heat conductor as moist heat at the same temperature, a much higher temperature is required for sterilization. The usual recommended practice is to hold the temperature at 320°F or 160°C for 2 hours. A 1-hour exposure at 340°F or 170°C is also effective.

Dry heat is suitable for sterilizing metal instruments that rust or dull in the presence of water vapor. However, the high temperatures used will destroy many rubber and plastic-based materials, melt the solder of most impressions trays, and weaken some fabrics, as well as discolor other fabrics and paper materials. One of the most common problems with dry heat sterilization is the failure to properly time the exposure. Dry heat penetration into the center of an instrument pack is slow and depends on both the size of the packages and the type of wrapping material. Because of this, appropriate preheating of the chamber is essential before beginning the sterilization cycle. A common misuse of the dry heat

method occurs when the sterilizer is opened, and an instrument is quickly removed during the timed cycle. This interrupts the cycle, and timing must begin all over again.

Advances in dry heat sterilization design resulted in a dry heat convection unit which uses forced air at higher temperatures (fig. 2-3). This method of rapid heat transfer achieves sterilization in 12 minutes at 375°F (190°C) for wrapped items and in 6 minutes for unwrapped items. Opening the door of this type of unit during the cycle has the same effect on the timing—the cycle is interrupted and the process must begin again. Consult the manufacturer's instructions for each type of dry heat sterilizer for specific operation details and user maintenance requirements.

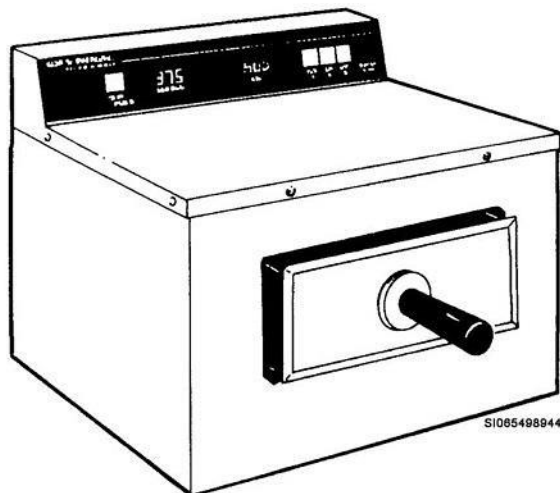


Figure 2-3. Dry heat convection sterilizer unit using the rapid heat transfer method.

Ethylene oxide

Ethylene oxide (ETO) is actually a chemical sterilant. It is a highly penetrative colorless gas at room temperature. The American Dental Association (ADA) and Centers for Disease Control (CDC) recognize this agent as an acceptable method of sterilization for heat and moisture-sensitive items. It is used at temperatures ranging from 80 to 140°F. Materials such as suction tubing, handpieces, radiographic film holders, and prosthetic appliances, may be sterilized using ETO without adverse effect. ETO sterilization depends on the correct balance of four essential parameters: concentration of the sterilant, relative humidity, temperature, and exposure. ETO sterilization equipment is not normally installed in USAF dental clinics. However, it is considered an acceptable method for nonheat sterilization of stable dental instruments when available through the MTF CSS.

14. Sterilization monitoring

Any number of factors can reduce the effectiveness of sterilizers. Overloading, and improper wrapping can prevent adequate penetration onto the instrument's surface. Improper timing, temperature variations, worn door gaskets and seals, and sterilizer malfunctions can prevent sterilization. As a means of quality assurance, chemical, mechanical indicators, and biological spore monitors are used to monitor the sterilization process.

Types of monitors

Chemical indicators are designed to change colors when exposed to the minimal heat and pressure conditions of sterilization. They *do not* prove that exact conditions and time required for sterilization are met. Therefore, chemical process indicators *do not* guarantee sterility of the pack contents. They do provide a quick, easy way to visually identify whether or not the packs are processed. Tape or bags with heat sensitive printing are examples of chemical process indicators. Lines on the tape and the printing on the bag darken after exposure to certain temperature ranges. Use chemical indicators on both the exterior and interior of packages, unless the internal indicator is visible from the outside.

Autoclave and dry heat sterilization (indicator) tapes are acceptable for use as internal or external indicators. However, use indicators *only* for the sterilization process for which they were designed.

Biological spore monitors are the most reliable way of determining the effectiveness of the sterilization cycle and sterility of processed items. They are commercially prepared in the form of strips and ampules. These preparations contain live bacterial spores that are more resistant to heat than viruses and vegetative bacteria. The bacterial spores are either suspended in a nutrient medium (ampule) or impregnated onto a test strip with the medium in an adjacent capsule. Spore tests are available for testing the effectiveness of steam under pressure, dry heat, and ethylene oxide gas sterilizers. *Geobacillus stearothermophilus* spores are appropriate monitors for steam under pressure while *Geobacillus atrophaeus* spores are more resistant to the conditions in dry heat and ethylene oxide. Some manufacturers combine both organisms in one ampule. Always check the manufacturer's instructions for proper use. The type of biological spore monitor selected must be appropriate to the sterilization process monitored.

Place biological spore strips or ampules in a location within the sterilizer that is least accessible to the sterilizing agent. This usually means within an instrument pack located in the lower front of the sterilization chamber in steam, under pressure sterilizers, or in the center of the load for tabletop units. After processing spore tests through a sterilization cycle, incubate them according to the manufacturer's instructions. A pH indicator, in the medium, changes color when spores germinate and produce acids. This visually identifies a failure in the sterilization process.

Perform biological spore monitoring at least weekly on all sterilizers in use. Run a biological spore test for each load that contains an implantable device. Additional testing may be recommended for some types of sterilizers. For example, prevacuum steam autoclaves require periodic testing for air removal, using the Bowie-Dick test or its equivalent.

Records

Record all sterilizer testing (e.g., spore tests, Bowie-Dick tests) results in a dental sterilization log. If the sterilizer is equipped with a printer or other automated system, the printout may be used as a record of sterilizer performance. Report the results of spore testing to the MTF infection control committee in the format and on the schedule established by local policy. Records are maintained for the length of time established by local statutes and MTF policy. *Minimum documentation includes:*

- Date and time of test.
- Sterilizer identification number.
- Sterilizing conditions—temperature and exposure period (automated documentation, if available).
- Load contents (operative, surgery)
- Person conducting test.
- Results of control.
- Results of test.
- Nature and date of any malfunctions or repairs performed.

Positive spore tests

Whenever any biological monitor reads positive, several steps must be taken. Record the positive spore test in the dental sterilization log and notify the dental infection control officer (ICO). Remove the sterilizer producing the positive test from service to prevent further use. Then recall and resterilize all instrument packs and items sterilized using that sterilizer since its last negative spore test. Contact medical equipment repair personnel to have the sterilizer checked.

In the meantime, check the expiration dates on monitors, retest the sterilizer with the monitors, and check the incubator for proper function. Positive results can be caused by a problem with the spore

test or the incubator rather than the sterilizer. In this case, a sterilizer can be returned to use when two consecutive *negative* spore tests are produced. The sterilization log is another area to check for possible causes. Review it for evidence of recent repairs, maintenance, or past sterilizer malfunction. Whenever a sterilizer requires repair, *three negative spore tests* must be produced before it can be returned to use.

15. Instrument processing

Dental instrument processing consists of three phases: (1) decontamination, (2) sterilization, and (3) sterile storage. Sterilization does not begin until the instrument is clean and free of debris. The presence of blood, tissue, oil, or other materials presents a barrier to steam or heat, and may render chemical agents completely ineffective. Therefore, you must thoroughly clean or decontaminate instruments before sterilizing them. After decontamination is complete, prepare instruments for sterilization by arranging as packs or trays with the necessary materials and supplies. Then place the items into a wrap or container appropriate for the sterilization method to be used. Seal the wrap or container and label it to include the expiration of the sterility of the pack. After the items are processed through a sterilization cycle, properly store them in order to maintain sterility.

Instrument processing usually takes place in a centralized sterilization area. There are many benefits to the centralized approach. Centralized instrument decontamination and sterilization activities are usually safer and more cost-effective than conducting instrument processing in the DTR. Eliminating large numbers of small capacity ultrasonic baths and tabletop sterilizers—in favor of larger capacity centralized equipment—can result in significant cost savings for initial purchase, replacement, and repair.

When working in a centralized sterilization area several factors affecting the design of the work area should be considered. The sterilization area should include work areas designated for receiving, decontaminating, preparation and packaging, sterilizing, and storing. In a centralized sterilization area an issuing area is also needed. Ideally, the receiving and decontamination area should be physically separated from the remainder of the sterilization area. Ultrasonic cleaners are located in the decontamination area. In the processing area ample work surface for the volume of materials processed is critical. All inspecting, sorting, wrapping, and packaging of materials occur in the processing area. *Do not* process instruments, materials, or equipment in an area or on a surface where sterilized items are handled. If this should occur, the area, surface, and any sterile items are considered *contaminated*.

Decontamination

Decontamination is considered the most critical step in instrument processing because disinfection and sterilization processes intended to kill microorganisms may not be effective if organic soil has not been removed by cleaning. Ideally, the decontamination process should be physically separate from dental treatment and other instrument processing areas.

When instruments cannot be immediately decontaminated, place them in a rigid, leakproof container containing a disinfectant solution or enzyme cleaner until they can be processed. *Do not* remove reusable sharps (e.g., *most dental instruments*) from these containers by hand—a practice prohibited by OSHA guidelines. Any container used to transport instruments to central sterilization or substerile areas must be red in color or have a biohazard label clearly visible.

Ultrasonic cleaner

Ultrasonic cleaning of contaminated dental instruments is generally safer and more effective than manual cleaning. The ultrasonic cleaner eliminates the possibility of accidental puncture wounds on hands, which frequently occurs with manual scrubbing. It also eliminates the spatter of organism-laden debris generated by scrubbing with a brush.

The ultrasonic cleaner uses electrical energy to generate sound waves. When the sound waves travel through liquid, millions of tiny bubbles form and burst continuously. This process is called

—acvitation.‡ The bursting bubbles scrub everywhere the liquid can penetrate. As a result, intricate surfaces and difficult access areas—burs, endodontic files, serrated instrument handles, and hinged instruments—are cleaned more thoroughly and rapidly. The useful life of cutting instruments, such as burs and endodontic files, is extended by thoroughly removing debris that interferes with cutting surfaces. Also, the ultrasonic cleaner has some disinfecting ability through the mechanical disruption of bacteria. However, it *does not* replace other sterilization procedures.

As illustrated in figure 2-4, several sizes of ultrasonic cleaning units are available. Locate ultrasonic cleaners in substerile or central sterilization areas. Follow the manufacturer's instructions when using ultrasonic cleaners. Post these instructions or make them readily available in locations where the units are used.

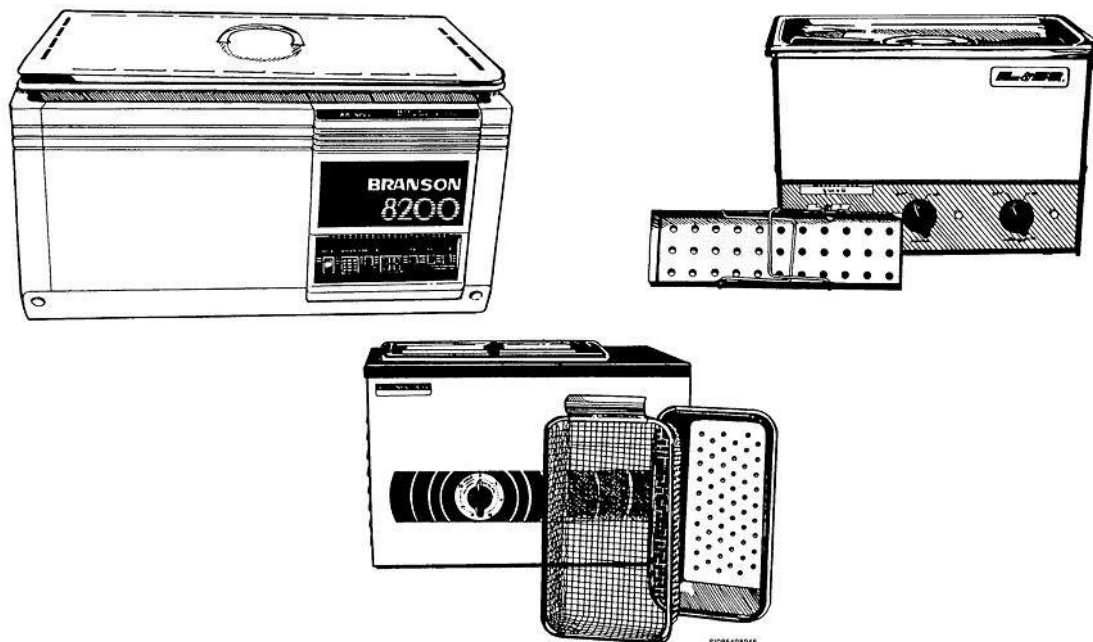


Figure 2-4. Ultrasonic instrument cleaners.

There are some general guidelines common to the proper use of all ultrasonic cleaners. Never use the ultrasonic in your DTR. Always keep the ultrasonic cleaner reservoir as full of ultrasonic cleaning solution as possible. It should be at least one-half ($\frac{1}{2}$) to three-fourths ($\frac{3}{4}$) full of solution at all times when in use. The solution must completely cover the items in order for the ultrasonic action to occur. Avoid using disinfectants, plain water, and nonultrasonic soaps or detergents. Change cleaning solutions at least daily—sooner if visibly contaminated.

You must degas a fresh solution before true ultrasonic cleaning can take place. Operating the unit without instruments in the reservoir for a few minutes does this. A distinctive hissing sound and churning or cold boiling of the solution indicates that the cleaning liquid is degassing.

When using the ultrasonic cleaner, first place instruments into a perforated or wire mesh basket and rinse under running water. Then place the basket with the instruments into the solution filled ultrasonic cleaner. Never place items directly on the bottom of tanks, because doing so reduces the amount of ultrasonic waves produced and can damage the unit. Always close the lid or cover on the unit when it is in operation in order to decrease aerosols and avoid splattering the solution onto adjacent surfaces. To avoid damage to instruments, limit ultrasonic cleaning times to 5 minutes, unless longer times are specified by the manufacturer. Longer cleaning times may be required for some nonmetallic instrument cassettes.

Never use your hands to remove instruments from the unit. Instead, use the basket to lift the instruments from the solution, drain, and rinse them under running water. Be sure to rinse the instruments thoroughly in order to remove all of the remaining solution. Inspect the instruments for remaining blood or debris and dry thoroughly.

Alternative methods

Washer-sterilizers and washer-decontaminator devices are commonly used in medical central sterile supply services. Contaminated instruments are placed in cassettes or baskets. Then they are run through the unit's cycle of cleaning, rinsing, and disinfection at temperatures high enough to provide at least a high level of disinfection. This results in a no touch system in which the potential for injury during instrument processing is greatly reduced.

Wrapping materials and containers

Dental instruments are usually placed in packs, on trays or cassettes before placing them into the sterilizer. Common wrapping materials and containers are paper, plastic/paper, nylon tubing, and cloth. Aluminum foil, closed metal trays, and perforated cassettes may also be used. The material or container used depends somewhat on the method of sterilization.

Cloth wraps are compatible with steam sterilization; however, they may char in dry heat. Cloth is *not* acceptable for use in forced air convection. Cloth wraps are sealed with adhesive indicator tape. When tape is placed on cloth wrappers, always turn a tab down on the tape. This provides a folded edge that aids in opening the package and removing the tape. Launder reusable cloth wraps and inspect them for tears or pinholes after each use. Quality disposable wraps are preferable to cloth.

Paper or combination paper/plastic materials are suitable with steam sterilization. In the dry heat method, the paper may burn, and the combination paper/plastic is *not* acceptable. Neither paper nor paper/plastic is suitable for forced air convection method. Paper and combination paper/plastic materials are available in the form of bags that are sealed with adhesive indicator tape.

Nylon tubing is suitable for use in steam and dry heat. However, there are two types of nylon tubing: heat stabilized and non-heat stabilized. *Heat stabilized* tubing is designed for use in dry heat *only*, and non-heat stabilized tubing is for steam *only*. Nylon tubing may be cut to the desired length and sealed with adhesive indicator tape.

Aluminum foil and closed metal trays are suitable in dry heat only. The closed metal tray, however, is *not* acceptable for use in the forced air convection. Perforated cassettes are compatible in steam and dry heat methods; however, they must be wrapped for terminal sterilization with an appropriate wrap. Additionally, you should check the manufacturer's recommendations because some cassette systems are not compatible with dry heat.

Expiration dates

After the instruments and supplies are wrapped or placed into containers and sealed, label them with the sterilizer identification number, the preparer's initials, and the date sterilized for event related method. Label and date packs before they are placed in the sterilizer. Use a pencil, ink marker, preprinted indicator tape, or a marking device that won't run or fade when exposed to sterilization. Do *not* use a grease or ink pen because they will run or fade. If you use a pencil, be careful not to tear the pack when you write on it. An ink marker effectively makes a permanent marking on pressure sensitive tape. Printed indicator tape is available and provides an efficient, legible, and standard way of labeling.

The shelf life or expiration date of sterilized items is the period during which an item is considered safe for use. Shelf life can be time-related or event-related. *Time-related* shelf life is identified with an exact expiration date. After this date, the item is considered to be outdated and should not be used. With an *event-related* shelf life, sterility is maintained indefinitely if packages are handled and stored properly. Several factors must be considered when assigning shelf life. These include storage location

(open or closed shelves), conditions of storage areas (cleanliness, humidity, and temperature), and the type of packaging or wrapping material.

The use of the event-related method presumes continued sterility until the package is damaged, wet, or torn. It is a well-recognized standard for items in good quality, self-sealed or hermetically (airtight) sealed, paper or plastic packaging and sequentially-wrapped items sealed in a dust cover within a few hours after sterilization. If this method is used, the policy must be clearly defined and consistently used throughout the facility.

Sterile storage

Sterility of dental materials, instruments and supplies is much harder to maintain than it is to achieve. There is little value in a precise sterilization procedure, if instruments are contaminated on completion of the process. Items must be dry before they are handled or stored. The time required for drying depends on the type of supplies in the load and the sterilizing agent used. Never place freshly sterilized items on metal or cold surfaces. Packages become damp from the condensation that occurs and become contaminated. If the sterilizer has a loading device, use it to allow the load to remain untouched until the items are totally cool.

Store all sterile supplies, including sterile reusable dental items, in a manner that will preserve their sterility until used. Several factors affect this process. Environmental conditions include cleanliness, proper ventilation, and control of excess heat and humidity are important. The location where sterile supplies are stored should not increase the possibility of contamination. Do *not* store sterile items in patient treatment or decontamination areas, unless they are protected by enclosures such as drawers or cabinets. Opening protective enclosures is discouraged while potentially contaminated aerosols or spatter are actively being generated. You may store sterile and clean patient treatment items in the same drawers or cabinets, as long as there is no possibility of similar nonsterile items being used inadvertently when sterility is required. Do *not* store sterile items with items not intended for clinical use (e.g., office supplies, cleaning supplies). Do *not* store items on the floor, under sinks, on window sills, adjacent to heating and air conditioning vents, or in any area where undetected contamination might occur. In addition, do *not* use shipping cartons to dispense sterile or clean patient treatment items.

When storing sterilized items, arrange them according to expiration date; place items with later dates toward the rear. Check supplies periodically to determine any need for resterilizing. Items must be resterilized if the wrapper becomes wet, if the pack touches the floor, if there is any question of contamination, or if the safe storage period has expired.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

013. Principles and types of sterilization

1. Define sterilization. Specify what this includes.
2. Since infection control standards call for sterilization of all instruments that will or are likely to penetrate the soft tissue, what does this include?
3. What methods of heat sterilization are currently accepted in USAF dental clinics?

4. What must the selected method of sterilization be compatible with?
5. How must all packs or rigid containers be labeled?
6. Why must packs or containers be arranged loosely in the sterilizer chamber?
7. Why must the manufacturer's instructions of the sterilizer equipment be followed? Where should copies of operating procedures be located?
8. How is proper function of the sterilizing equipment ensured?
9. What is the basis of steam under pressure sterilization?
10. Why does the saturated steam process take longer for large linen packs?
11. What must take place after the sterilization is complete to maintain sterility?
12. What are the crucial components of the steam-under-pressure process?
13. What is the purpose of using pressure? Briefly explain.
14. What reduces the heating and penetrating power of the steam?
15. Why is the packaging of supplies and loading of the sterilizer important?
16. Define flash sterilization.
17. What may happen if items made of carbon steel are steam-sterilized?

18. Briefly describe how steam sterilizers should be cleaned. Why?
19. Who should check the sterilizer, if it does not appear to function properly?
20. What should you frequently spot-check sterilizers for?
21. What are three types of widely-used steam sterilizers?
22. How is the air removed from the chamber in the gravity displacement sterilizer? What slows this process when the sterilizer is filled with supplies?
23. What precautions are taken when loading the sterilizer chamber?
24. How is the sterilizer loaded if mixed loads of metal items and linen are sterilized together?
25. Why are fluids sterilized separately?
26. Why are supplies never put into a heated sterilizer until it is time for the sterilization to start?
27. What will cause the pressure required to maintain sterilizing temperature to vary?
28. As a recommended standard, when is steam sterilization achieved?
29. How can the speed and efficiency of the steam sterilizer be improved? What is this type of sterilizer?
30. What causes the cycle of the prevacuum sterilizer to vary?

31. At what temperature and length of time are wrapped instruments sterilized in a prevacuum sterilizer?
32. What test was developed for prevacuum sterilizers to determine if the air has been removed from the chamber during the prevacuum stage?
33. Briefly explain how to carry out the sterilization test using autoclave tape.
34. What must be done if the Bowie-Dick test indicates inadequate air removal?
35. Explain how instruments are decontaminated in washer-sterilizers.
36. Identify and define the type of sterilization achieved after the washer-sterilizer cycle is complete.
37. Why is the use of washer-sterilizers beneficial?
38. What is final sterilization? When is it accomplished?
39. What are the requirements for accomplishing the destruction of microorganisms by dry heat in a dental facility?
40. What are the temperature and time requirements for dry heat sterilization?
41. What are the disadvantages of the high temperatures of dry heat sterilization?
42. What is one of the *most common problems* with the use of dry heat sterilization?
43. What is a common misuse of the dry heat method?

44. What type of sterilizer uses forced air at higher temperatures to rapidly transfer heat and achieve sterilization? What are the time and temperature requirements for sterilization?
45. ETO is recognized as an acceptable method of sterilization for what type of items and by whom?
46. What are the four essential parameters which depend upon the correct balance for ETO sterilization?
47. When is ETO considered an acceptable method for USAF dental clinics?

014. Sterilization monitoring

1. What is used as a means of quality assurance to monitor the sterilization process?
2. Chemical process indicators do not prove or guarantee what? What is their purpose? When must chemical process indicators be used?
3. What is the most reliable way of determining the effectiveness of the sterilization cycle and sterility of processed items?
4. What types of spores are used to test steam under pressure and sterilization? Which are used in dry heat and ethylene oxide?
5. Specify where biological spore strips or ampules should be placed within the sterilizer.
6. What happens to the pH indicator in the medium after incubation?
7. When is biological spore monitoring required?
8. Where are the results of all sterilizer testing recorded?

9. To whom and how are the results of spore testing reported?
10. What are the *minimum* documentation requirements?
11. What steps must be taken if any biological monitor reads positive?
12. What can you do to determine if a positive spore test is *not* the result of sterilizer malfunction?
13. What other area should you check when a *positive* spore test occurs? Why?
14. What must be produced before returning a repaired sterilizer to use?

15. Instrument processing

1. What are the three phases of instrument processing?
2. Why must instruments be thoroughly decontaminated before they are sterilized?
3. How are instruments prepared for sterilization after decontamination?
4. What are the benefits of a central sterilization area?
5. What designated work areas should the sterilization area include?
6. What two areas should be physically separated from the remaining sterilization areas?
7. In what area are ultrasonic cleaners located?
8. What takes place in the processing area?

9. What must be done if instruments cannot be immediately decontaminated?
10. What are the requirements if a container is used to transport instruments to central sterile or substerile areas?
11. Why is ultrasonic cleaning of contaminated instruments safer than manual cleaning?
12. What makes ultrasonic cleaning of instruments more effective?
13. How much ultrasonic solution is required in the reservoir?
14. How often must the solution be changed?
15. What must be done with a fresh solution before true ultrasonic cleaning can take place? How is this done?
16. Why are items never placed directly on the bottom of tanks?
17. Why must the lid or cover always be on the unit when it is in operation?
18. What is the time limit for ultrasonic cleaning?
19. How should you remove instruments from the unit?
20. What alternative methods result in a no touch system which reduces the potential for injury during instrument processing?
21. What method of sterilization is compatible with cloth wraps? How often must reusable cloth wraps be laundered and inspected for tears and pinholes?

22. What sterilization method is suitable for paper or combination paper/plastic materials?
23. Identify the two types of nylon tubing; and the suitable sterilization method.
24. What sterilization methods are suitable for perforated cassettes?
25. What information is placed on the label of packs, trays, or cassettes? When and how is this done?
26. Briefly explain time-related shelf life.
27. What is event-related shelf life?
28. What factors are considered when assigning shelf life?
29. You should *not* store sterile items in what areas?
30. When storing sterilized items how do you arrange them?
31. When must sterilized items be resterilized?

2–2. Clinical, Radiology, and Laboratory Procedures

We need to practice aseptic techniques during clinical, radiology, and laboratory procedures. In the past, infection control in many areas of radiology and the dental laboratory were simply overlooked. As you will see in this section, this is no longer the case. The lessons in this section cover aseptic techniques as they apply to different activities beginning with clinical procedures, then covering both conventional and digital radiology infection control and concluding with a final lesson on laboratory infection control.

16. Clinical procedures

The procedures discussed in this lesson are additional components of aseptic clinical techniques. As you know, the ultimate goal of aseptic techniques is to break the chain of infection and eliminate the possible transmission of infectious disease between patients and staff. Aspects of aseptic techniques are required when preparing for patient treatment, during treatment, and after the patient is dismissed.

Like other areas we have discussed, there are aseptic techniques that can be tailored for different items which are discussed in the following paragraphs.

Supplies

You must always use clean forceps to dispense supplies. All clinical setups should have at least two sets of forceps—one used for intraoral treatment procedures; the other used only for dispensing consumables from bulk storage containers. *Never use hands for this purpose!* Careful planning should eliminate the need to enter drawers or cabinets during procedures. Removal of gloves and handwashing, or using impervious barriers or overgloves, is required when cabinets or drawers must be entered during treatment. Dispense disposable items in the quantity required to treat a single patient or unit dose. If possible, include these items in sterile instrument packs.

Needles

Never recap a needle using a two-handed technique. Use a recapping device or the scoop technique. In this technique, the cap is scooped up from the tray with the needle tip using only one hand. Never allow uncovered needles to remain on the instrument tray. Do *not* bend, break, or otherwise manipulate needles by hand except to remove needles from *nondisposable* dental anesthetic syringes. Needles are single-use disposable items and are disposed after each patient. Place used disposable sharps in puncture resistant containers specifically designed for that purpose. These containers should be placed in each DTR.

Instruments and the DTR

You must never lay contaminated instruments directly on countertops or work surfaces. Use a patient drape or other type of barrier on the surface to limit contamination. Remove the contaminated instruments from the immediate patient treatment area prior to breakdown and decontamination of the DTR. Do *not* seat the next patient in the DTR until all decontamination procedures related to the previous patient have been completed. This includes, but is not limited to, such tasks as removing and replacing contaminated barriers, disinfecting all contaminated surfaces or items, and flushing all water lines.

Handpieces

Between patients, clean and heat-sterilize (steam autoclave) all handpieces, including low-speed attachments and ultrasonic scaler tips. Chemical disinfection of dental handpieces is *not acceptable* in USAF dental clinics. Using chemical disinfectants on dental handpieces is discouraged by all major handpiece manufacturers and may void the warranty if damage occurs. Most manufacturers require that handpieces be lubricated before and after sterilization. To prevent cross-contamination, use two separate containers of lubricant—one prior to sterilization and another after sterilization. Lubricate handpieces with one end in a headrest cover in order to contain the microorganisms and debris removed with the lubricant.

Biopsy specimens

Biopsy specimens require special handling. Place them in sturdy, properly labeled, leak-proof containers. If the outside of the container becomes visibly contaminated while collecting specimens, clean and disinfect it or place the container in an impervious bag. Specimens placed in formalin are *not* considered biohazardous but do pose a potential chemical hazard and should be labeled and handled in accordance with OSHA hazardous materials rules.

Spills

In the event of spills involving blood or other potentially infectious material (OPIM), using a commercially available spill kit is recommended. If a blood or OPIM spill occurs, don appropriate PPE and rubber gloves and follow the manufacturer's instructions.

Wastes

Even waste products and evacuation systems have specific requirements. Place all regulated waste in designated leakproof containers identified either by the color red or by a biohazard label. Empty liquid infectious wastes into the sanitary sewer system through clinical sinks—preferably *not* handwashing sinks—or unit cuspidors, unless local regulations prohibit this practice. Disinfect the high volume evacuator using an evacuation system cleaner. Follow the manufacturer’s instructions for dilution and quantity.

Miscellaneous

Sometimes it is the simple things that cause us to break asepsis. To prevent cross-contamination, always annotate dental records, view radiographs, and take photographs after removing gloves and washing your hands, unless you wear overgloves. If the dental record or radiographs are exposed to aerosols or possible cross-contamination during patient treatment, slip them into a headrest cover, or place a piece of clear plastic over them. **REMEMBER**—before leaving the DTR, remove and discard the gloves and the mask that you wore during patient treatment.

17. Dental digital radiology infection control

Digital x-ray equipment and associated supporting devices provide distinctive challenges with infection control procedures. Several items such as the computer, keyboard, mouse, and printer cannot be disinfected or sterilized, and are considered a clinical contact surface. For this reason you must avoid contaminating these supporting devices. Equipment used in the treatment room requires a different level of infection control compared to equipment used outside the treatment room. One way to prevent contamination is using good hand-hygiene prior to touching equipment. Additionally, using plastic protective barriers can protect these items when necessary. If these supporting devices will not be contacted or contaminated by spatter, then no barrier is required.

Radiographic positioning devices

Positioning devices are heat tolerant or disposable; your clinic may have one type, or both. Prior to using on a patient, cleaning, packaging, and heat sterilizing is required for each device. If using disposable positioning devices, ensure that you dispose of them after each patient use. Do *not* reuse or attempt to heat sterilize disposable devices. Follow the appropriate infection control steps for the type of device you are using.

Digital radiographic sensors/imaging plates

The standard digital sensors/plates used in the USAF dental clinics are Schick, Kodak, and Air Techniques. These sensors/plates have direct contact with mucous membranes; therefore, they are considered semicritical devices. Semicritical devices should be cleaned and heat-sterilized between patients; however, the sensors/plates cannot tolerate heat sterilization. Use infection control for these devices with a FDA approved plastic protective barrier. Recommended steps for sensors/plates are listed below.

Schick or Kodak sensors

1. Barrier protect sensor and cords that may contact intraoral surfaces.
2. After procedure, remove barrier and dispose properly.
3. Between patients, clean and disinfect the sensor with an EPA-registered intermediate-level disinfectant. Using intermediate-level disinfecting wipes may be easier than spraying the sensor.
4. Consult the manufacturer for questions or concerns regarding the proper care of the equipment.

Air Techniques imaging plates

1. Barrier protect the imaging plate.

2. After procedure, remove the barrier and dispose of properly.
3. Clean plate with —100% cotton gauze and isopropyl alcohol and dry plate completely.
4. Consult manufacturer for questions or concerns regarding the proper care of the equipment.

18. Dental laboratory infection control

Standard precautions for preventing exposure to bloodborne pathogens govern laboratory activities just as they do in other areas of dentistry. The most effective practical method for protecting laboratory personnel is implementing a strict clean laboratory system. This system is essentially a series of physical cleaning procedures (barriers) designed to rid a prosthesis or impression of organic debris and microorganisms through a step-wise process of mechanical and chemical cleaning and disinfection. The result is a product that can be safely handled by laboratory personnel. Clean and disinfect all prostheses and impressions and deliver them to the dental laboratory in a plastic barrier (headrest cover). Rigidly enforce the laboratory clean system. Do not permit ~~rush cases~~ to violate the integrity of the infection control system.

Treatment of impressions

Complete the cleaning and rinsing of the impression in the DTR. If necessary, a small amount of dental stone may be sprinkled into the impression before rinsing to aid in the cleaning process. Impression disinfection must be accomplished in the DTR. The impression must be thoroughly sprayed (using a nonmisting dispenser) with or dipped in an appropriate intermediate-level spray or immersion disinfectant and placed in a bag (headrest cover) for the recommended contact time. Once the appropriate time has elapsed, remove the impression from the bag and rinse under plain water. Then place the impression into clean bag marked with the appropriate patient information. Change disinfectant solutions according to manufacturer's recommendations or when visibly contaminated.

The disinfectant and the method used must be compatible with the composition of the impression material. Polysulfide and addition silicone impressions, such as polyvinylsiloxane, can be disinfected by immersion with any of the accepted products without affecting accuracy and detail reproduction. In fact, the surface detail is enhanced with 2 percent acidic glutaraldehyde solutions. Polyether impressions may be adversely affected by immersion disinfection. To minimize dimensional change, use a chlorine compound product with a short disinfection time or disinfect the impression with a spray. Alginate impressions produce more accurate casts when disinfected by spray rather than immersion. Consult the product information for both the impression and disinfectant material for compatibility and exposure times.

Occlusal records, wax bite rims, and prostheses undergoing initial clinical try-in are handled as if they are impressions as far as the barrier system is concerned. Make slurry water from fresh-set stone that has never been poured against a potentially contaminated impression. Clean and heat-sterilize reusable impression trays between patients.

Treatment of prosthesis

A combination of factors, including time considerations and the lack of heat stability of many items, makes heat sterilization of all prostheses entering the laboratory impractical. For most prostheses, cleaning and chemical disinfection will remain the principal mechanism of reducing contamination. Initially scrub all prosthetic devices with a brush and antimicrobial soap to remove gross debris and contamination. Perform this procedure in the DTR. Heat-sterilize or store brushes in a container filled with an approved disinfectant. Place the prosthesis in a container filled with ultrasonic cleaning solution or calculus remover and place it in an ultrasonic cleaner for the required time specified by the manufacturer. Place the cover on the ultrasonic cleaner to reduce the spread of aerosols. Inspect the item for adequate cleaning before disinfection. If ultrasonic cleaning does not remove all surface

deposits, the use of a shell blaster may be indicated. Use aseptic techniques similar to those described for daylight loaders in order to avoid contaminating the shell blaster.

After adequate cleaning is complete, immerse the appliance in a 1:10 dilution sodium hypochlorite solution for 10 minutes or a high-level disinfectant for the time recommended by the manufacturer to achieve high- or intermediate-level disinfection. Consult the manufacturer's data for information on the frequency with which solutions must be discarded and remixed (reuse life). Sodium hypochlorite solutions should be remixed at least daily. After disinfection, rinse the prosthesis under running tap water, dry, and complete the required work.

Clean and disinfect all prostheses and other potentially contaminated materials sent to other facilities before they leave the dental laboratory. Place casts, impressions, or prostheses into a disposable plastic bag prior to packing.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

016. Clinical procedures

1. What is the ultimate goal of aseptic techniques?
2. Why should all clinical setups have at least two sets of forceps?
3. What is required when cabinets or drawers must be entered during treatment?
4. How are disposable items dispensed for patient treatment?
5. What are the requirements when handling needles?
6. How are disposable sharps discarded?
7. How can countertops or work surfaces be protected when handling contaminated instruments?
8. What should be accomplished prior to the breakdown and decontamination of the DTR?
9. What should be completed prior to seating the next patient in the DTR?

10. What must be done with all handpieces, including low speed attachments, and ultrasonic scaler tips between patients?
11. How can cross-contamination be prevented when lubricating handpieces?
12. What are the special handling requirements for biopsy specimens?
13. What kind of spill kit is recommended and how do you use it?
14. Briefly explain what to do if a spill of blood or OPIM occurs.
15. How are liquid infectious wastes discarded?
16. What actions are required, to prevent cross-contamination, before annotating dental records, viewing radiographs, and taking photographs?
17. What must you do before leaving the DTR?

017. Dental digital radiology infection control

1. What digital radiology items are considered clinical contact surfaces and cannot be disinfected or sterilized?
2. What is required prior to using a radiographic positioning device on a patient?
3. What are the standard digital sensors/plates used in the USAF dental clinics?

018. Dental laboratory infection control

1. Where is cleaning and rinsing of impressions done?

2. Where is impression disinfection performed?
3. Briefly explain the process of disinfecting an impression.
4. What type of impression materials can be disinfected by immersion with any of the accepted products?
5. What type of disinfectant or method should be used to disinfect polyether impressions?
6. What method of disinfecting produces a more accurate cast from an alginate impression?
7. What care is required of reusable impression trays?
8. Briefly explain the steps required for prosthetic devices entering the laboratory.

Answers to Self-Test Questions

013

1. The process by which all forms of life are completely destroyed. The destruction of all microbial life forms such as bacteria, fungi, viruses, and bacterial spores.
2. Surgical instruments, rubber dam clamps, scalers, scalpels, periodontal probes, and matrix retainers.
3. Steam under pressure (autoclave) either gravity displacement or prevacuum, dry heat, and unsaturated chemical vapor.
4. The items to be sterilized, sterilization wraps, adhesives and containers.
5. With the sterilizer identification number, initials of the person who wrapped the pack, load number, and the date of expiration.
6. Overloading the chamber prevents achieving sterilization evenly throughout the load.
7. (a) The manufacturers make recommendations for appropriate cycle lengths and other operating parameters. Scheduled maintenance and calibration of sterilization equipment must be performed according to the manufacturer's recommendations.
(b) Posted or readily available in all areas where sterilization is done.
8. Done at least weekly with biological spore monitoring.
9. Transfer of heat to an article by condensation.
10. Each successive layer must be penetrated by saturated steam and heated as the steam condenses on the cool material. This process continues until all areas of the pack have been heated to the same temperature as the surrounding steam.
11. Items must dry completely before removing.
12. Steam temperature and exposure time.

13. It is used only to raise the temperature of the steam and, in itself, has nothing to do with microbial killing action. At 15 psi, the boiling point increases to 121°C (250°F), a temperature at which all known organisms are killed.
14. Air that forms cool air pockets in the sterilizer.
15. Both must be done so that the steam comes into contact with all areas of surfaces of the items being sterilized.
16. The sterilization of unwrapped items in a gravity displacement or prevacuum sterilizer with recommended minimum exposure times and temperatures.
17. It dulls their cutting edges.
18. Use a mild detergent to wash the surfaces. Follow the wash with a thorough rinse of plain water. Unless this is done, the chamber walls will collect mineral deposits and may become greasy.
19. Medical equipment repair personnel.
20. Leaks in lines and improperly functioning gauges, dials, thermometers, doors, drain strainers, and valves.
21. Gravity displacement sterilizer, prevacuum high-temperature sterilizer, and instrument washer sterilizer.
22. Air is evacuated downward and outward from the chamber through the chamber discharge line. Air may be trapped around and, more frequently, inside the supplies, keeping the steam from contacting all portions of the items and preventing sterilization in that area.
23. Do not overload. The passage of steam from the top of the chamber to the bottom should not be blocked. Place all packages on edge, with large packs at the bottom of the chamber, and small packages in an upper layer crosswise to lower layer.
24. Linen is placed on the upper shelf and metal items on the lower.
25. The pressure must be slowly released.
26. Supplies exposed to such heat before sterilization causes fabrics to dry, superheat, and incur damage during sterilization.
27. Altitude.
28. At 250°F or 121°C after 20–30 minutes at 15 psi.
29. (a) By removing air from the chamber with a powerful pump, creating a nearly perfect vacuum before steam is introduced into the chamber.
(b) The prevacuum steam sterilizer.
30. The size of the sterilizer, the adequacy of steam, and the supply of water.
31. 270°F (131°C) after 4-minute exposure.
32. Bowie-Dick.
33. Place 3 or 4 pieces of tape on the fabric in a crisscross manner with the fabric layer arranged in a test pack that allows the tape strips to extend from the edge to the center of the pack at a given layer depth. Conduct the test after the warm-up cycle is completed. Place the test pack in the bottom front of an otherwise empty chamber. After exposure open the test pack and check the tape. The tape shows by its color change the pattern of residual air, if any, that remained in the pack during the sterilization cycle. Uniformity of the color change, not the intensity, is the significant factor.
34. Medical equipment repair personnel must be notified and the sterilizer must be repaired before the prevacuum cycle can be used.
35. Instruments used in patient care are placed in rigid, reusable container systems, such as cassettes or baskets. The cassettes or baskets are loaded into the washer-sterilizer which cleans the objects with mechanically agitated water and detergent, similar to that of a dishwasher.
36. Terminal sterilization. Sterilizing items immediately after use in patient care before further processing.
37. Since the instruments are processed through the washer-sterilizer prior to technician handling, the risk of injury from contaminated instruments during processing is greatly reduced.
38. Processing items after terminal sterilization. After assembling, and wrapping of packs or trays.
39. Using a unit that has been tested and approved as a commercial sterilizer by the FDA.
40. Temperature of 320°F (160°C) for 2 hours or 340°F (170°C) for an hour.

41. It destroys many rubber- and plastic-based materials, melts the solder of most impressions trays, and weakens some fabrics, as well as discolors other fabrics and paper materials.
42. The failure to properly time the exposure.
43. It occurs when the oven is opened and an instrument is quickly removed during the timed cycle. This interrupts the cycle, and timing must begin all over again.
44. Dry heat convection unit. 12 minutes at 375°F (190°C) for wrapped items and 6 minutes for unwrapped items.
45. Heat and moisture-sensitive items; the ADA and CDC.
46. Concentration of the sterilant, relative humidity, temperature, and exposure.
47. For nonheat stable dental instruments when available through the MTF CSS.

014

1. Chemical and mechanical process indicators, and biological spore monitors.
2. That exact conditions and time required for sterilization are met. Therefore, they do not guarantee sterility of the pack contents. Provide a quick, easy way to visually identify whether or not the packs are processed. Both the exterior and interior of packages, unless the internal indicator is visible from the outside.
3. Biological spore monitors.
4. *Geobacillus stearothermophilus*; *Geobacillus atrophaeus*.
5. The location least accessible to the sterilizing agent which is usually within an instrument pack located in the lower front of the sterilization chamber in steam under pressure sterilizers or in the center of the load for tabletop units.
6. It changes color when spores germinate and produce acids, which then visually identifies a failure in the sterilization process.
7. At least weekly on all sterilizers in use, and for every load with an implantable device.
8. In a dental sterilization log.
9. The MTF infection control committee in the format and on a schedule dictated by local policy.
10.
 - (a) Date and time of test.
 - (b) Sterilizer identification number.
 - (c) Sterilizing conditions—temperature and exposure period (automated documentation, if available).
 - (d) Person conducting test.
 - (e) Results of control.
 - (f) Results of test.
 - (g) Nature and date of any malfunctions or repairs performed.
 - (h) Load contents.
11.
 - (a) Positive result recorded in the dental sterilization log and the dental ICO notified.
 - (b) Remove the sterilizer producing the positive test from service to prevent further use.
 - (c) All instrument packs and items sterilized since the last negative spore test must be recalled and resterilized.
 - (d) Medical equipment repair personnel must be contacted to check the sterilizer.
12. Check the expiration dates on monitors, retest the sterilizer with the monitors, and check the incubator for proper function.
13. The sterilization log. Review it for evidence of recent repairs, maintenance, or past malfunction of the sterilizer.
14. Two negative spore tests.

015

1. Decontamination, sterilization, and sterile storage.
2. The presence of blood, tissue, oil, or other materials present a barrier to steam or heat, and may render chemical agents completely ineffective.
3. Arranged as packs or trays with the necessary materials and supplies. Placed into a wrap or container suitable for the sterilization method used. Sealed and labeled to include the sterility expiration date.

4. Usually safer and more cost-effective than performing instrument processing in the DTR.
5. Receiving, decontaminating, preparation and packaging, sterilizing, storing, and issuing.
6. Receiving and decontamination.
7. Decontamination.
8. All inspecting, sorting, wrapping, and packaging of materials.
9. They must be placed in a rigid, leakproof container containing a disinfectant solution or enzyme cleaner until ready for processing.
10. It must be red in color or be affixed with a biohazard label.
11. Eliminates the possibility of accidental puncture wounds on hands which frequently occurs with manual scrubbing. Eliminates the splatter of organism-laden debris generated by scrubbing with a brush.
12. Bursting bubbles scrub everywhere the liquid can penetrate. Intricate surfaces and difficult access areas are cleaned more thoroughly and rapidly. Use life of cutting instruments is extended by thoroughly removing debris that interferes with cutting surfaces. Some disinfecting ability through the mechanical disruption of bacteria.
13. At least $\frac{1}{2}$ to $\frac{3}{4}$ full and must completely cover the items for the ultrasonic action to occur.
14. At least daily or sooner if visibly contaminated.
15. Degassed; Operate the unit without instruments in the reservoir for a few minutes.
16. Doing so reduces the amount of ultrasonic waves produced and can damage the unit.
17. To decrease aerosols and avoid splattering of the solution onto adjacent surfaces.
18. 5 minutes unless longer times are specified by the manufacturer.
19. Never use your hands to remove instruments. Use the basket to lift the instruments from the solution, drain, and rinse under running water.
20. Washer-sterilizers and washer-decontaminators.
21. Steam; after each use.
22. Steam sterilization.
23. Heat-stabilized used in dry heat only; nonheat stabilized for steam only.
24. Steam and dry heat methods (some cassette systems are not compatible with dry heat).
25. Sterilizer identification number, preparer's initials, and date of expiration. The label and date must be entered using a pencil, ink marker, preprinted indicator tape, or a marking device that won't run or fade when exposed to sterilization before the items are placed in the sterilizer.
26. It is identified with an exact expiration date. After this date, the item is considered to be outdated and should not be used.
27. Sterility is maintained indefinitely if packages are handled and stored properly.
28. Storage location (open or closed shelves), conditions of storage areas (cleanliness, humidity, temperature), type of packaging or wrapping material.
29. (a) In patient treatment or decontamination areas unless protected by enclosures such as drawers or cabinets.
(b) With items not intended for clinical use (e.g., office supplies, cleaning supplies).
(c) On the floor, under sinks, on window sills, adjacent to heating and air conditioning vents, or in any area where undetected contamination might occur.
30. According to expiration date, placing items with later dates toward the rear.
31. If the wrapper becomes wet, if the pack touches the floor, if there is any question of contamination, or if the safe storage period has expired.

016

1. To break the chain of infection and eliminate the possible transmission of infectious disease between patients and between patients and staff.
2. One for intraoral treatment procedures; the other only for dispensing consumables from bulk storage containers.
3. Remove gloves and handwashing, or use impervious barriers or overgloves.

4. In the quantity required to treat a single patient, or unit dose, and included in the sterile instrument packs if possible.
5. Never recap a needle using a two-handed technique. Use a recapping device or the scoop technique. Never allow uncovered needles to remain on the instrument tray. Do not bend, break, or otherwise manipulate needles by hand, except to remove needles from non-disposable dental anesthetic syringes.
6. In puncture-resistant containers in the DTR specifically designed for that purpose.
7. Never lay the contaminated instruments directly on countertops or work surfaces. Use a patient drape or other type of barrier on the surface to limit contamination.
8. All instrument cleaning should be completed and the contaminated instruments should be removed from the immediate patient treatment area.
9. All decontamination procedures related to the previous patient.
10. Cleaned and heat sterilized.
11. Use two separate containers of lubricant—one prior to sterilization and another after sterilization. Lubricate handpieces with one end in a head restcover to contain the microorganisms and debris removed with the lubricant.
12. Place biopsy specimens in sturdy, properly labeled, leak-proof containers. If the outside of the container becomes visibly contaminated while collecting specimens, clean and disinfect or place the container in an impervious bag.
13. A commercially available one; use it according to the manufacturer's instructions.
14. Don appropriate PPE and rubber gloves and follow manufacturer's instructions.
15. Emptied into the sanitary sewer system through clinical—not handwashing—sinks or unit cuspidors, unless local regulations prohibit this practice.
16. Remove gloves and wash hands unless overgloves are worn.
17. Remove and discard gloves and mask worn during patient treatment.

017

1. Items such as computer, keyboard, mouse and preinter.
2. Cleaning, packaging, and heat sterilization for each device.
3. Schick, Kodak, and Air Techniques.

018

1. DTR.
2. In the DTR.
3. The impression must be thoroughly sprayed (using a nonmisting dispenser) or dipped in an appropriate intermediate- or high-level immersion disinfectant and placed in a sealed bag (charged atmosphere). Mark the bag with the appropriate patient information and the time the disinfection process started.
4. Polysulfide and addition silicone impressions, such as polyvinylsiloxane.
5. A chlorine compound product with a short disinfection time or disinfected with a spray.
6. Spray.
7. Thoroughly cleaned and heat-sterilized between patients.
8.
 - (1) Initially scrub with a brush and antimicrobial soap to remove gross debris and contamination.
 - (2) Place in a container filled with ultrasonic cleaning solution or calculus remover and place in an ultrasonic cleaner for the required time as specified by the manufacturer.
 - (3) Inspect the item for adequate cleaning before disinfection. If ultrasonic cleaning does not remove all surface deposits, the use of a shell blaster may be indicated.
 - (4) After adequate cleaning, immerse the appliance in a 1:10 dilution sodium hypochlorite solution for 10 minutes or a high level disinfectant for the time recommended by the manufacturer.

Do the unit review exercises before going to the next unit.

Unit Review Exercises

Note to Student: Consider all choices carefully, select the *best* answer to each question, and *circle* the corresponding letter.

41. (013) What methods of heat sterilization are currently accepted in USAF dental clinics?
 - a. Steam under pressure, dry heat, and rapid forced air dry heat.
 - b. Gravity displacement, prevacuum, forced air dry heat, and salt.
 - c. Steam under pressure, either gravity displacement or prevacuum, and dry heat.
 - d. Steam under pressure, gravity displacement, prevacuum, dry heat, convection, and salt.
42. (013) How do you sterilize items which *cannot withstand heat*?
 - a. Gravity displacement.
 - b. Ethylene oxide.
 - c. Convection.
 - d. Prevacuum.
43. (013) The *crucial* components of the *steam under pressure* process are
 - a. steam temperature, exposure time, and pressure.
 - b. steam temperature and exposure time.
 - c. steam temperature and pressure.
 - d. exposure time and pressure.
44. (013) To properly load the chamber of the gravity displacement unit
 - a. place all packages on edge, with large packs at the bottom of the chamber, and small packages in an upper layer.
 - b. arrange items to prevent blocking the steam from circulating from the bottom to the top of the chamber.
 - c. place linen items on the lower shelf and metal items on the upper shelf.
 - d. place supplies in the heated unit until it is time for the process to start.
45. (013) What sterilization process is accomplished *after* the washer-sterilizer cycle?
 - a. Terminal sterilization.
 - b. Final sterilization.
 - c. Decontamination.
 - d. Disinfection.
46. (013) What is the temperature (Fahrenheit) and time required for *sterilization in a dry heat oven*?
 - a. 250°F for 2 hours or 300°F for 1 hour.
 - b. 320°F for 2 hours or 340°F for 1 hour.
 - c. 350°F for 2 hours or 375°F for 1 hour.
 - d. 375°F for 2 hours or 400°F for 1 hour.
47. (013) Sterilization using the *rapid heat transfer method* requires what temperature (Fahrenheit) and time exposure?
 - a. 350°F for 20 minutes.
 - b. 375°F for 12 minutes.
 - c. 425°F for 6 minutes.
 - d. 475°F for 20 minutes.

48. (014) When exposed to *minimal heat and pressure conditions of sterilization* what changes colors and indicates whether or not the packs have been processed?
- a. Chemical indicators.
 - b. Bowie-Dick tests.
 - c. Spore monitors.
 - d. Spore test.
49. (014) How often *must* biological spore monitoring be performed if implantable devices are in the load?
- a. Monthly.
 - b. Weekly.
 - c. Daily.
 - d. Every cycle.
50. (015) The ultrasonic cleaner is located in which area?
- a. Receiving.
 - b. Processing.
 - c. Sterilization.
 - d. Decontamination.
51. (015) When can ultrasonic instrument decontamination be performed in the dental treatment room?
- a. Never.
 - b. Between patient care.
 - c. When using ultrasonic cleaner.
 - d. When directed by the hospital infection control officer.
52. (015) Which of the following does *not* apply to the proper operation of ultrasonic cleaners?
- a. The solution must completely cover the items.
 - b. Use the lid or cover on the unit when in operation.
 - c. Use a disinfectant, plain water, or soap for the solution.
 - d. First place instruments into a perforated or wire mesh basket and rinse under running water.
53. (015) Non-heat stabilized nylon tubing is designed for which sterilization method?
- a. Steam.
 - b. Dry heat.
 - c. Dry heat and steam.
 - d. Forced air convection.
54. (015) What sterilization method is used for aluminum foil and closed metal trays?
- a. Dry heat.
 - b. Gravity displacement.
 - c. Steam under pressure.
 - d. Instrument washer sterilizer.
55. (015) Freshly sterilized items are
- a. stacked near a fan to dry.
 - b. stacked on top of one another to dry.
 - c. placed on metal or cold surfaces to dry.
 - d. never placed on metal or cold surfaces to dry.

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56. (015) Stored sterile items *must* be resterilized if the safe storage period has expired,
- a. the wrapper becomes wet, if the pack touches the floor, or if there is any question of contamination.
 - b. the wrapper becomes wet, or if the pack touches the floor.
 - c. or the wrapper becomes wet.
 - d. or the pack touches the floor.
57. (016) What methods can be used to recap needles?
- a. Scoop technique and recapping device.
 - b. Two-handed technique and scoop techniques.
 - c. Two-handed technique and recapping device.
 - d. Recapping device, two-handed technique, and scoop techniques.
58. (016) In addition to cleaning, what *must* be done with all handpieces, including slow speed attachments and ultrasonic scaler tips, between patients
- a. Disinfect by a spray and wipe technique.
 - b. Chemically sterilize by immersion.
 - c. Disinfect by immersion.
 - d. Heat sterilize.
59. (017) When do digital radiology supporting devices need barrier protection?
- a. When contacted or contaminated by spatter.
 - b. Only when disinfected.
 - c. Only when sterilized.
 - d. Never.
60. (017) You clean the Air Techniques imaging plates with
- a. EPA-registered intermediate-level disinfectant.
 - b. immersion in intermediate-level disinfectant.
 - c. 100% cotton gauze and isopropyl alcohol.
 - d. .50% Sodium hyperchloride solution.
61. (018) Where should the *initial* cleaning and rinsing of an impression be done?
- a. Receiving area.
 - b. Dental laboratory.
 - c. Dental treatment room (DTR).
 - d. Central instrument processing area.
62. (018) What *impression materials* can be *disinfected* by immersion with any of the accepted products without affecting accuracy and detail reproduction?
- a. Polysulfide and addition silicone.
 - b. Addition silicone and polyether.
 - c. Polysulfide and polyether.
 - d. Polyether and alginate.

Student Notes

Unit 3. Dental Radiology

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THE X-RAY WAS DISCOVERED by William Conrad Roentgen in November 1895 in Wurzburg, Bavaria, while he was experimenting with a cathode ray tube in his darkened laboratory. Though Roentgen did not know the tube was emitting radiation, he observed a glowing phosphorescent-coated screen (similar to a screen used to view motion pictures). Roentgen called the new rays that caused this phenomenon *x-rays* because their properties and existence were previously unknown. He went on to learn that x-rays penetrate such substances as wood.

That same year, Dr. Otto Walkoff, a German dentist/experimenter, produced the first dental radiographs. Obviously, since then, x-ray use in dentistry has increased dramatically as it now plays a prominent part in most diagnoses of dental disorders. Conventional x-rays are becoming obsolete and being replaced by digital radiographic technology. The Air Force now uses digital radiology as its sole source for producing radiographs.

019. Digital imaging

As you learned earlier, quality radiographs must be produced consistently in order for the dentist to have the best diagnostic tool possible. You must thoroughly understand the principles of radiology in order to perform the various x-ray exposure techniques accurately and safely. Since radiation can be dangerous, it's important that you produce a good diagnostic radiograph each time so that you avoid unnecessarily exposing the patient to radiation.

This new and innovative process has a very short history in dentistry. It is fast becoming the standard in today's world and in the future may replace silver-halide based film. As you have just learned, digital radiography does not replace the entire radiographic process, just the processing procedures. What does all this mean? Let's find out.

Equipment required

When using the digital radiography method, you use an x-ray machine the same way that you would with the conventional method of exposing radiographs. You will also use the items described in the following paragraphs.

Digital intra-oral image receptors

The receptor is a charged-coupled device (CCD) composed of an x-ray or light sensitive array of semiconductors on a silicon chip. This electronic sensor is available in sizes that correspond to regular x-ray film. The sensor is enclosed in a piece of hard plastic and has a fiber-optic cable that is directly wired to the computer. This allows for immediate transfer of the radiograph to the computer.

NOTE: The CCD is very fragile ... HANDLE WITH CARE.
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Image plates are used just like radiographic film. They are packaged in the same way as traditional film—between disposable sanitary barriers. They are similar to the intensifying screens used in extraoral radiographs. When the x-rays strike the screen, it instantly converts the energy to light (photons). This light then exposes the imaging plate. The resulting *x-ray* is not released from the imaging plate until it is scanned with an image scanner. Once the imaging plate has been scanned, the image is released and the plate can be reused.

Image scanner

After you expose the image plate, you place it on the image scanner for processing. Within the scanner, a laser scans the plate, capturing the image in a digital format which can be displayed on the computer monitor. The scanner reads the imaging plate one pixel (dot) at a time and records the number of photons detected to produce the digital image. Thousands of pixels are required to generate a single digital image.

Computer with monitor

The heart of digital radiography is the computer and monitor. The computer is equipped with special software to support this technology. The processed images are stored on the computer's hard drive or on removable disks.

Laser printer

The laser printer is used to produce a hard copy of the digital image. Images from the laser printer can be provided to other facilities that do not have digital radiography access. No matter how advanced you become technologically, there will always be a place for some hard copy form of digital images.

Advantages and disadvantages

First, let's take a look at some of the advantages of digital radiography. One advantage is that the processing time for an image is reduced to seconds instead of minutes. The image can now be viewed in a shorter time because there is no film processing. Because the image is directly viewed on a computer monitor, the dentist can zoom in on questionable areas, adjust the contrast or density, and duplicate images faster. Another advantage is the elimination of chemical processing of radiographs and, consequently, elimination of the silver recovery program. Finally, digital radiography uses less radiation—four to eight times—than normal speed conventional x-ray film, reducing both technician and patient exposure.

However, there are some disadvantages to digital radiography. First, the small image area of some image receptors may require taking twice as many films to achieve desired results. Second, the CCD image receptor is very fragile. Also, the digital radiography systems are very expensive. In addition, the image can be altered, presenting a legal issue. Finally, transfer of images cannot be accomplished unless all the dental clinics have the same software/computer capability. This means that you would have to print a hard copy of the image for the patient to take to another dental clinic that has a different or no digital system.

Digital radiographic process

Digital radiology is based on information acquired by using a computer as the main component of the digital system. Keep in mind that the x-ray machine, though not a part of the system, is a key element that produces the x-rays required to produce the image. The initial part of digital radiography is the same as taking conventional radiographs. The procedure for producing a digital image is described in the following table.

Digital Radiographic Process	
Step	Action
1	Turn on the x-ray machine and computer.
2	Drape the patient with a lead apron and thyroid collar.
3	Explain the procedure to the patient.
4	Check the x-ray source exposure setting. The proper setting on the x-ray source depends on several factors, among them, the tube type, the anatomy of the patient, and the location of the sensor.
5	Place the sensor in the holder, then place the protective sheath over the sensor and holder.

Digital Radiographic Process	
Step	Action
6	Place the sensor in the patient's mouth with the flat side facing the x-ray tube.
7	Position the x-ray tube adjacent to the area where the sensor is in place.
8	Expose the image receptor using the settings recommended by the manufacture. When using the CCD, an image is immediately sent to the computer for processing.
9	Process the storage phosphor plates using the image scanner. Attach the plates to the developing carousel and then place the carousel into the image scanner. You do not need a darkroom when loading the image scanner carousel. You may load the carousel in an area with subdued lighting.
10	The image plate scan is initiated from the computer. The scanning time depends on the surface area being scanned. Scanning times are usually from 1 to 3 minutes.
11	The computer converts the analog signal from the image scanner to a digital signal for storage. The image is then converted back to an analog signal so that the dentist can examine it on the monitor.

Note that the preceeding are only general guidelines. Step-by-step procedures for digital radiography systems vary by manufacturer. It is *very important* that you refer to the manufacturer's instructions for operating the system, equipment preparation, patient preparation, and exposure factors prior to the first time you use any digital system.

Production of dental images

Digital images play an important role in diagnosing dental disease. The digital image allows the dentist to view areas of the teeth and surrounding structures that cannot be seen with a mouth mirror and an explorer. Using digital radiographs, the dentist can diagnose caries and find out how far the disease has progressed. Other purposes include visualization of impacted teeth and the alveolar bone level. Later we'll discuss how dentists can communicate with each other instantly for a patient's diagnosis!

Determining types of images

Images are only taken when prescribed by a dentist. The dentist decides what types of images, if any, are needed. The decision to request images is influenced by several factors such as the patient's age, type of appointment (sick-call, exam, etc...) and the patient's frequency of caries development.

Digital Imaging is a film-less imaging system that uses electronic sensors or storage phosphor imaging plates (PSP) instead of film to record images. When the x-ray beam strikes the sensor, an electronic charge is produced on the sensor's surface; the sensor, in turn, sends the impulse directly to the computer which digitizes the electronic impulses it receives. These impulses allow the computer to almost instantaneously produce a diagnostic image on a monitor. In contrast, PSP plates require a processor unit to scan the digital image into the computer. Once the images are in the computer, digital imaging software can be used to manipulate the images and enhance their appearance for interpretation and diagnosis.

Advantages/disadvantages

While most clinics have digital imaging capability, it is possible that you may be stationed at a base that still uses conventional methods to take dental x-rays. Regardless, the proficiency in taking digital images that you achieved in technical training can be used for both digital and conventional imaging techniques. In any case, you'll need to be aware that the new digital technology used for Air Force dental x-rays has both advantages and disadvantages. These are summarized in the following table.

Advantages	Disadvantages
<ul style="list-style-type: none">• Digital imaging software allows the user to zoom in and magnify any area of the image.• Contrast or density can be adjusted.• Processing time is quicker and no chemicals are required.• Images can be mailed electronically.• Images can be duplicated faster.• Sensors and PSP plates are reusable.	<ul style="list-style-type: none">• High implementation cost because of the equipment required.• Digital image storage requires large amounts of disk space, or optical disk storage.• It's an emerging technology, which means there's no standardized format and equipment becomes obsolete quickly.• Possible legal issues due to the ability to manipulate images.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

019. Digital imaging

1. What are the two types of image receptors?
2. Briefly describe each type of image receptor.
3. What is the function of the image scanner?
4. What is used to produce a hard copy of the digital image?
5. List the advantages of digital radiography.
6. List the disadvantages of digital radiography.
7. Briefly describe the procedure to take a digital radiograph.
8. What is done prior to first-time use of a digital system?
9. The dental image allows the dentist to view what areas? List them.
10. Who is the ONLY individual that can prescribe digital x-rays?

11. Describe the transition of the x-ray beam.

20. X-rays and safety precautions

Digital imaging has basically the same properties as conventional radiology. It is important to note that with digital imaging the patient receives a substantially lower level of radiation. Radiation waves are considered discrete units of energy called quanta or photons. Radiation waves travel in a wave motion similar to light or radio waves and move at the speed of visible light (186,000 miles/second). The length of an 'x-ray' radiation wave is extremely short, only 1/10,000 that of visible light—about one billionth of an inch. Waves such as light or AM radio waves have the tendency to bounce off or be reflected by many objects. This is due to their long wavelengths, which provide little or no penetrating power. X-ray radiation waves, in contrast, have very short wave lengths and, therefore, have the penetrating power to pass through many substances.

Now, think of a form of energy with wavelengths hundreds of millions of times shorter than radio waves. Imagine their penetrating ability!

X-rays

All matter is composed of atoms. The atom is made up of protons, neutrons, and electrons. Protons and neutrons are found in the center, or nucleus, while the electrons orbit around the nucleus. Each of these is defined in the following table.

Atomic Particle Definitions	
Particle	Definition
Nucleus	Accounts for almost all of the atom's mass and furnishes the force that causes electrons to spin around (orbit) the nucleus.
Protons	Are positive charged particles in the nucleus. Every atom has at least one proton.
Neutrons	A nucleus particle with no electrical charge. They are required to stabilize the atomic structure of more complex atoms. A stable atom has an equal number of protons and electrons.
Electrons	Have a negative electrical charge.

Ionization occurs when an energy source removes electrons from electrically stable atoms. Radiation is produced when these high speed electrons strike matter. Radiation travels at 186,000 miles/second (speed of light) in straight lines. Its short wavelengths and high penetrating ability make it very useful for dental applications.

The types of radiation are: primary, secondary, and scatter. *Primary radiation* is the useful beam that comes directly from the center of the tube head. *Secondary radiation* is radiation emitted from objects which the primary beam has passed through, and *scatter radiation* is radiation which has been redirected or deflected.

There are two characteristics that you must be familiar with in order to produce diagnostic quality radiographs—density and contrast. The key part of that statement is diagnostic quality. Its one thing to produce an image, but quite another to produce an image of the caliber that the dentist can make a diagnosis from. In addition to these characteristics there are two other terms that you need to be familiar with. Each of these is discussed in the following table.

X-ray Related Terms	
Term	Description
Density	Density relates to the degree of darkness on an image. A radiograph with high density allows little light to pass through it to your eyes. Low density will allow almost all of the transmitted light to be passed through it to be seen by the eyes. Density is an important factor of image quality because a certain amount of density is obviously needed in order to form a quality diagnostic image.
Contrast	Contrast refers to the darkness and lightness (differences in density) on various areas of the images. Contrast is important because it defines or better demonstrates the structure under examination.
Radiopaque	Radiopaque structures are dense and do not permit the passage of radiation. The more radiopaque a structure, the lighter it appears on the image.
Radiolucent	Radiolucent tissues are less dense and do permit passage of radiation. The more radiolucent a structure, the darker it appears on the image.

Safety precautions

You use the same safety precautions with digital imaging that you would with conventional radiology. Just because digital imaging produces less radiation, does not mean you should not use safety precautions to the fullest extent. Let's touch on some safety concerns when exposing a patient to radiation.

Radiation health

An important consideration in the field of dental radiology is adequate protection for both the operator and patient. Any body tissue may be injured by excessive exposure to radiation. The cumulative effect of radiation exposure can be extremely harmful. In the average dental radiographic examination, the amount of radiation received by the patient is quite small; only a fraction of which would be harmful. However, radiation can be absorbed by the human body and cause permanent damage. The amount of damage is determined by the following factors:

- Quantity (amount) of radiation exposure.
- Quality (intensity) of radiation exposure.
- Length (time) of exposure.
- Type of tissue irradiated.

Patient protection

The patient is protected by a variety of methods. First, we use the ALARA (As Low as Reasonably Achievable) concept. This means exposing the patient to the lowest possible dose of radiation that will produce a diagnostically acceptable radiograph. The next "protection" requires proper operator techniques; this reduces retakes. We also use a lead apron for our patient's protection. The lead apron should cover the chest, throat, and lap areas so that the thyroid gland and reproductive organs are protected. It is also very important to ask female patients if there is a chance that they may be pregnant!

Filtration

Another method of patient protection is filtration. Modern radiographic equipment is equipped with a 2.5-mm thick aluminum segment at the window where short wavelength radiation exits the tube-head. This aluminum filter absorbs the poor quality, long wavelength radiation. It provides an important degree of safety from the primary beam without adversely affecting the quality of the radiograph. Due to this filtration, only the higher quality radiation waves reach the patient.

Collimation

Another method of patient protection is accomplished through what is known as collimation. Collimation reduces the exposure area of the primary beam. The beam is shaped or collimated to the

desired diameter by a lead diaphragm located outside the aluminum filter. It limits the size of the useful beam to a *maximum* of a $2\frac{3}{4}$ inch diameter at the skin surface.

Lead lined cone

The cone, or cylinder, is lead-lined in order to absorb or reduce the scatter radiation as the x-ray beam travels down the cone towards the teeth. This feature minimizes the amount of scatter radiation that both the patient and dental assistant can be subject to while images are being captured.

We also use a step wedge. The step wedge checks exposure settings and processing daily (prior to first patient exposure).

Operator protection

The ALARA concept serves as the operator's guide or safe capturing techniques.

Education and proper operator techniques will also ensure the operator's safety. The lead barriers the operator stands behind during exposure provides added protection. The dosimeter/film badge helps track and detect cumulative operator radiation exposure. Other personnel in the clinic are also protected from exposure by the walls, floor, and ceiling which are usually lined with lead, concrete, or steel. Lead impregnated glass in the control area also adds extra protection for the operator.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

020. X-rays and safety precautions

1. Radiation waves travel at what speed?
2. What are the three types of radiation?
3. Define density.
4. Define contrast.
5. Who should be protected during radiation exposure?
6. What does the acronym "ALARA" stand for?
7. What function does the step wedge serve?

021. Patient preparation

At the beginning of each duty day, you will need to ensure that your radiology equipment is functioning properly. This is done to prevent unnecessary re-taking of radiographs. To accomplish this, turn on the unit and adjust the controls by following the procedures below.

Milliamperage

The first setting is the mA or milliamperage. Milliamperage is the amount of electricity that is applied to the tungsten filament. Milliamperage, along with exposure time, governs the amount of radiation produced. Using the manufacturer's instructions adjust the milliamperage taking into account the patient's body size.

Kilovoltage

The next setting is the kV or kilovoltage. Kilovoltage controls the radiation's quality by shortening the wavelength which provides increased penetration power. Kilovoltage is also the "pressure" that forces the electric current through the circuit. It governs the speed at which the electrons travel between the cathode and anode. This speed determines the wavelength of the resulting radiation. The shorter the wavelength, the more penetrating power the radiation wave has. High kilovoltage results in a short wavelength which is directly related to the quality of the radiation and the x-ray results. Like the milliamperage, adjust the kilovoltage in accordance with the manufacturer's instructions and the patient's body size.

Exposure time

The third setting is the exposure time. Exposure time determines the amount of time the equipment is activated to expose the radiograph. Exposure time varies based on the equipment and the technique you are using. Again, you adjust the exposure time in accordance with the manufacturer's instructions and the patient's body size.

Preparing the patient for radiographs

Once you have adjusted your equipment, you are ready to prepare your patient for taking radiographs. In order to successfully prepare your patient for radiographs, it's best to follow these steps.

Remove all jewelry and use a lead apron

Have patients remove any removable objects from the neck up that may interfere with the radiograph, i.e. eyeglasses, removable prostheses devices (RPD), or jewelry. Have the patient seated upright and ensure that he or she is covered with a lead apron to protect vital organs.

Planes of reference

In order to obtain a quality diagnostic radiograph, the patient must be in the proper position. Two planes of reference are critical to proper patient positioning.

Planes of Reference	
Plane	Description
First	<p>The first plane is the median sagittal or mid-sagittal plane.</p> <p>This is an imaginary line drawn vertically through the center of the body.</p> <p>It should be perpendicular to the floor for all exposures.</p>
Second	<p>The second plane of reference is the occlusal plane and is the curvature from the incisal edges of the central incisors to the tips of the occlusal surface of third molars.</p> <p>It should be parallel to the floor with the mouth slightly open for all maxillary and mandibular exposures.</p>

Remaining still and hold one's breath

Explain to your patient that he or she must remain still while the image is being captured because movement may distort the image. If exposing a panograph or a cephalograph, have the patient swallow; then have the patient lift the tongue to the top of the mouth.

As the final step tell your patient to take a deep breath and hold it in until the machine beeps. This doesn't take very long and holding the breath helps prevent movement which could result in an unsatisfactory radiograph and the need to repeat the process.

Caution: It is *critically important* that you ask female patients if they are or could be pregnant. If they state that they may be, consult your dentist prior to making any exposures.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

021. Preparing a patient for radiographs

1. How often do you check to ensure that your radiographic equipment is functioning?

2. List the three control devices you will need to adjust.

3. What items do you need to have your patient remove prior to an x-ray?

022. X-ray film, sensors, and storage plates

In this lesson, we discuss the types and characteristics of digital film that are most commonly used in the Air Force. The two digital film categories are intra-oral and extra-oral radiographic images. We'll also cover the different types of images that make up these broad categories. We conclude this lesson with a discussion of the differences between intra-oral sensors and PSP plates. While they are both used for imaging, there are differences between them that are important to note.

Intra-oral images

There are three types of intra-oral images—horizontal/vertical bitewings, periapical, and occlusal. Each one has a different purpose and can detect certain conditions. Each of these is described in the following table.

Intra-Oral Images	
Type	Description
Horizontal/vertical bitewings	Horizontal/vertical bitewings (BW) record crowns, alveolar crest, and interproximal areas (max and man) of posterior teeth. These images detect proximal caries on posterior teeth. The difference between horizontal and vertical bitewings is that vertical bitewings measure bone level in periodontal patients.
Periapical	Periapical (per) records crowns, roots, and supporting structures of individual teeth and detects abnormalities of individual teeth and supporting structures. Periapicals can be used with a bite-tab to assemble vertical or horizontal bitewings.
Occlusal	Occlusal images record large areas of the maxilla, mandible, or floor of the mouth and detect gross pathological condition and/or fractures.

Extra-oral image

There are two types of extra-oral images—panograph and cephalometric. Each is used for a different purpose as detailed below.

Extra-Oral Images	
Type	Description
Panograph	Panograph (Pano) records the complete maxilla and mandible and is used for screening or evaluation of oral pathology/injuries. This image provides a view of the facial aspect of the patient.
Cephalometric	Cephalometric records the complete maxilla and mandible and is used for screening or evaluation of oral pathology/injuries also. This image provides a view of the lateral aspect of the patient.

Intra-oral sensors

For our purposes, a sensor is basically a fiber optic cable connected to a computer. The sensor captures an image and then transmits the image to the computer. The image appears on the computer screen within seconds of exposing the sensors. Sensors are extremely fragile and expensive but are reusable because the image is stored on a computer and not the sensor itself. The sensors can be erased and reused for different patients.

Storage phosphor imaging plates

For dental imaging these are flexible plates coated with phosphor. They are also thinner than sensors. These phosphorous storage plates (PSP) are the same size as traditional films, reusable, and are a wireless method for capturing dental images. After exposure, you remove the plates from the patient's mouth and place in an electronic processor called the Scan-X. The processor's laser scans the plate and produces an image that is transferred to the computer screen for viewing.

Much like reusing a diskette, each PSP plate must be erased before it can be used. Note that PSPs are light sensitive and exposure to bright light for an extended period will cause your image to fade or be completely erased.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

022. X-ray film, sensors, and storage plates

1. List and define the three types of intra-oral images.
2. List and define the two types of extra-oral images.
3. Explain the intra-oral sensor and its function.
4. Explain the phosphorus storage plate and its function.

023. Digital image processing

Like any other procedure, there are steps that must be accomplished before and after using a digital sensor or PSP to take an image. In this lesson we cover the steps that are required in order to effectively expose and download images and use the imaging scanner. We'll finish up with a discussion of other important radiograph procedures that need to be performed. Let's begin with exposing and downloading images.

Exposing and downloading images

In this segment we go through the step-by-step sequence for exposing and downloading an image when using a digital sensor or a PSP. We'll begin with the digital sensor.

Digital sensor

To complete the task of exposing and downloading an image using a digital sensor, perform the following steps:

Exposing and Downloading Digital Sensor Images	
Step	Action
1	Place infection control barriers on computer equipment. This is done to prevent cross contamination.
2	Open the digital radiology software program (MiPACS).
3	Select the patient's image record (or create new record) by typing in the patient's social security number.
4	Perform step wedge test and adjust timing controls. This task is done to prevent re-exposure.
5	If the patient is female, verify whether or not she may be pregnant. Follow local guidance if the answer is yes.
6	Select template for type of digital image to be exposed.
7	Place infection control barrier on digital sensor.
8	Expose requested digital image.
9	Image will be displayed on created template for viewing.
10	Post exposure <ul style="list-style-type: none"> • Select an image by clicking on it. • Under Image Properties (bottom left), locate anatomic information. • Under "Description" drop down menu, select type of region/location of image (ex. upper right molar) to identify the area of the mouth the exposure was taken.
11	Click on Save icon.
12	Under Series Description Box, describe/label digital radiograph taken (ex. PA # 30).

Storage phosphor imaging plates

The steps to complete the task when using PSP plates are a bit different than those when using the sensor. As you'll recall, when using a digital sensor the image goes directly to a computer and can be viewed immediately. In order to view an image taken with a PSP plate, you perform the the steps listed below.

Exposing and Downloading PSP Images	
Step	Action
1	Place infection control barrier on plates to be exposed. This step is necessary because the plate will be used on other patients and <i>cannot</i> be disinfected. Place printed side of PSP facing clear side of barrier. Peel adhesive strip, seal barrier.
2	Perform step wedge test and adjust timing controls. This task is done to prevent unnecessary re-exposure.
3	Expose digital PSP.
4	Turn off lights. Use a barrier to prevent cross contamination.
5	Remove the film from barrier using aseptic technique and place into transfer box. The transfer box protects the images prior to being processed.
6	Remove remaining barriers.
7	Remove your gloves and wash your hands.
8	Remove the apron and dismiss your patient.
9	Transfer the box containing all exposed PSP plates to the processor room.
10	Place the box next to the available Scan X processor and turn the processor on.
11	Open Mipac Dental Enterprise Viewer 3.1 and log on.
12	The "Find Patient" box will appear. Enter the patient's last name; click "search".
13	Double click on the patient's name.
14	Select the template Ex. PA 3, this step is performed to label the image.
15	Click on "Show Template".
16	Click on the "Intra-oral Standard" icon. The red button move from idle to active.
17	Wait for the "ready" light to turn green before inserting PSP plates in the Scan X.
18	Place the PSP plates in the Scan X slot with the printed side facing you. Avoid touching the center.
19	Once scan is complete, in series description box type "PSP-PA 3;" exit out of program.
20	Place PSP plates back into the transfer box and return them to your dental treatment room.

Exposing Specific Dental Images

Now that you are familiar with using the digital sensor and PSP to capture digital images, let's turn our attention to the procedures for exposing specific dental images. We'll begin with taking intra-oral images and then cover extra-oral images.

In the following discussions we'll cover how to take these images using both the digital sensor and the PSP plates for each task. The steps for each technique are the same except for placing barriers. When placing a barrier on the digital sensor, you simply slide a plastic barrier over the sensor and down the cord. You insert PSP plates into a saliva proof barrier and remove the white tape. After removing the white tape, you seal the plate just like you would an envelope.

Your dentist may request that images to be taken either with the sensor or PSP plates, so you need to be prepared to use both types of exposure techniques. Let's begin with bitewing images!

NOTE: Some clinics may not have the ~~horizontal~~ digital sensor. The clinic may only have the standard size sensor.

Vertical bitewings

For vertical bitewings you use a periapical PSP plate/sensor with bite tabs. Ensure that the long dimension is vertical and perpendicular to the floor. If you are taking a bicuspid view, center the film on the second bicuspid. If you are taking a molar view, center the plate or sensor on the second molar. For the bicuspid view, place the forward edge of the PSP plate/sensor to the distal $\frac{1}{3}$ of the most anterior cuspid.

To expose vertical bitewings with four images, follow the steps listed below:

Exposing Vertical Bitewings with Four Images	
Step	Action
1	Place infection control barriers to prevent cross contamination.
2	Review the patient's record for health history and type of radiograph requested.
3	Gather four (4) PSP's with bitetabs and sensor plate (place bitetab on flat side of sensor).
4	Open MiPACS program/turn on sensor image scanner.
5	Select patient's digital image record and select appropriate template for capture.
6	Adjust the x-ray control panel to required settings in order to prevent re-exposure.
7	Brief the patient on the procedure.
8	Provide the patient with a lead apron and thyroid cervical collar.
9	Place long axis of PSP/sensor perpendicular to occlusal plane and the floor.
10	Center PSP/sensor vertically on contact of first and second molar for the <i>molar</i> view. Center PSP/sensor vertically on the second bicuspid for the <i>bicuspid</i> view
11	Instruct the patient to close gently.
12	Position the patient with occlusal plane parallel to floor.
13	Establish parallel relationship between cone opening and PSP/sensor. The opening should rest lightly against the patient's cheek.
14	Establish a parallel relationship between cone opening and PSP/sensor.
15	Center the bite tab in cone opening to ensure the entire image is captured.
16	Stand behind protective barrier. Expose image.
17	Repeat steps for remaining images

Periapical images

For periapical images you use the extension cone paralleling instruments (XCP). The XCP ensures that the images are perpendicular to the patient's teeth. The primary beam is projected at a right angle to the PSP Plate/sensor (perpendicular). Place the film parallel to the long axis of the tooth. Avoid sharp bending or crimping of the PSP plate/sensor as it will result in a distorted image. Contouring should be done gently.

WARNING: Under **NO CONDITIONS** hold the PSP for the patient during the exposure! **NEVER** stand in the path of the primary beam.

Avoid sliding the PSP over the mucous membrane as this may trigger the gag reflex which could then make exposing radiographs extremely difficult. Have the patient breathe deeply or extend his or her leg to reduce the chance of gagging. Extreme cases may require application of a topical anesthetic. Use a PSP—one for anterior and one for posterior—in conjunction with XCP instruments. Sterilize them between patients.

To expose periapical full mouth images, you follow these steps:

Exposing Periapical Full Mouth Images	
Step	Action
1	Place infection control barriers to prevent cross contamination.
2	Review patient's record for health history and type of radiograph requested.
3	Gather fourteen (14) PSP's with bitetabs and sensor plate (place bitetab on flat side of sensor).
4	Open MiPACS program/turn on sensor image scanner.
5	Select patient's digital image record and select appropriate template for capture.
6	Adjust x-ray control panel to required settings in order to prevent re-exposure.
7	Brief the patient on the procedure.
8	Place a lead apron with thyroid cervical collar on the patient.
9	Place sensor/PSP in biteblock of XCP.
10	Place biteblock behind and parallel to long axis of appropriate tooth.
11	Instruct the patient to close down gently on the biteblock.
12	Establish parallel relationship between cone opening and locator ring to ensure the entire image is captured.
13	Place x-ray cone parallel to indicator rod.
14	Stand behind protective barrier. Expose image.
15	Repeat steps for remaining images

Bisecting angle technique

The bisecting angle is used when the paralleling technique cannot be used. Examples of when to use the bisecting angle include patients with small mouths or arches and children. There are three imaginary lines that help position the tube-head for the radiographs. First, visualize a line through the long axis of the tooth and then through the film packet. The two lines meet to form an angle. The line dividing the angle in half is the bisecting line. The primary beam is directed at a 90° angle to the bisecting line.

To expose images using the bisecting angle technique, follow the steps listed below:

Exposing Images Using the Bisecting Angle Technique	
Step	Action
1	Place infection control barriers in order to prevent cross contamination.
2	Review the patient's record for health history and type of radiograph requested.
3	Gather PSP with bitetab and sensor plate (place bitetab on flat side of sensor).
4	Open MiPACS program/turn on sensor image scanner.
5	Select the patient's digital image record and select the appropriate template for capture.

Exposing Images Using the Bisecting Angle Technique	
Step	Action
6	Adjust the x-ray control panel to required settings in order to prevent re-exposure.
7	Brief the patient on the procedure.
8	Provide the patient with a lead apron and thyroid cervical collar.
9	Load PSP into holding device (hemostat/snap-a-ray)/prepare sensor. Place behind target tooth.
10	Instruct the patient to hold the instrument with his/her hand to keep the PSP/sensor steady. OR place using the XCP instrument.
11	Adjust the conehead to ensure tooth apex is included in image using bisecting angle technique. OR adjust the conehead to the aiming ring of the XCP instrument.
12	Instruct the patient to remain still.
13	Stand behind protective barrier. Expose image.
14	Repeat steps to expose remaining images.

Panograph image

To expose a panograph image, follow these steps:

Exposing a Panograph Image	
Step	Action
1	Place infection control barriers in order to prevent cross contamination.
2	Review the patient's record for health history and type of image requested.
3	Gather panograph PSP and sensor plates (carefully place the PSP/sensor plate into the cassette and load into the unit). <ul style="list-style-type: none"> • White part of PSP/sensor plate facing toward red side of cassette. • Red side of cassette faces patient.
4	Open MiPACS program/turn on sensor image scanner.
5	Select the patient's digital image record and select the appropriate template for capture.
6	Adjust the x-ray control panel to required settings in order to prevent re-exposure.
7	Brief the patient on the procedure.
8	Instruct the patient to remove metallic items and removable prostheses from head and neck area. this step is done to prevent unwanted images showing up.
9	Provide the patient with a lead apron and thyroid cervical collar (ensure that the collar does not interfere with exposure).
10	Place infection control barrier over biteblock
11	Panoramic unit with <i>patient standing</i> : <ul style="list-style-type: none"> • Instruct patient to stand facing the panoramic unit, with feet on the footprints. • Instruct patient to grasp panoramic unit handles. • Instruct patient to stand "tall" with the back straight. This is done to help hyperextend the patient's neck.

Exposing a Panograph Image	
Step	Action
12	Panoramic unit with <i>patient seated</i> : <ul style="list-style-type: none"> • Instruct patient to sit in the panoramic unit. • Instruct patient to sit “tall” with the back straight.
13	Adjust the lift mechanism to allow the patient’s chin to rest on the chin rest
14	Hyperextend the neck.
15	Instruct the patient to close on a specific area of unit biteblock.
16	Instruct the patient to tilt head forward/backward to align parallel to occlusal plane.
17	Ensure the patient’s back is still straight.
18	Instruct the patient to place the tongue flat against hard palate, close lips, swallow, and remain still.
19	Adjust the x-ray unit settings IAW manufacturer’s recommended instructions for patient size.
20	Stand behind protective barrier. Capture image by fully depressing the unit’s button until the machine comes to a complete stop.

Cephalograph image

To expose a cephalograph image, follow the steps listed below:

Exposing a Cephalograph Image	
Step	Action
1	Place infection control barriers in order to prevent cross contamination.
2	Review the patient’s record for health history and type of radiograph requested.
3	Gather cephalometric PSP (carefully place the PSP into the cassette and load into the unit). <ul style="list-style-type: none"> • White part of PSP facing toward red side of cassette. • Red side of cassette faces patient.
4	Open MiPACS program, select Ceph template.
5	Select the patient’s digital image record and select the appropriate template for capture.
6	Adjust the x-ray control panel to required settings in order to prevent re-exposure.
7	Brief the patient on the procedure.
8	Instruct the patient to remove metallic items and RPDs from the head and neck area.
9	Provide the patient with a lead apron and thyroid cervical collar (ensure the collar does not interfere with exposure).
10	Instruct the patient to stand in the ceph area, adjust the machine height, place ear guides into ear holes, and place soft tissue ruler against the top of the nose.
11	Instruct the patient to tilt the head forward/backward to align parallel to the occlusal plane.
12	Ensure the patient’s back is still straight.
13	Instruct the patient to touch the tip of the tongue to the hard plate, close lips naturally, swallow, and remain still.
14	Stand behind protective barrier. Capture the image by fully depressing the unit button until the machine comes to a complete stop.

Occlusal image

To expose an occlusal image, follow these steps:

Exposing an Occlusal Image	
Step	Action
1	Place infection control barriers in order to prevent cross contamination.
2	Review the patient's record for health history and type of radiograph requested.
3	Adjust the x-ray control panel to the required settings in order to prevent re-exposure.
4	Brief the patient on the procedure.
5	Provide the patient with a lead apron and thyroid cervical collar.
6	<i>Mandibular</i> occlusal exposures: <ul style="list-style-type: none"> • Position the patient with face parallel to ceiling. • Insert occlusal film with embossed dot away from mandibular arch. • Instruct the patient to close down gently on the film. • Position the x-ray tubehead at a 90° angle to the film packet for mandibular exposures.
7	<i>Maxillary</i> occlusal exposures <ul style="list-style-type: none"> • Position the patient sitting upright with the ala-tragus line parallel to the floor. • Insert the occlusal film with embossed dot away from maxillary arch. • Instruct the patient to close down gently on the film. • Position the x-ray tubehead at a 65–75° angle to film packet, centered over the bridge of the nose.
8	Instruct the patient to remain still.
9	Stand behind protective barrier. Expose image.

By now you can see how involved taking images, including exposing and downloading, really is. Up to this point, we have discussed critically important steps that need to be followed in order to provide the best possible care for your patients. In the next lesson, we will consider actions that need to be done once the images have been scanned and saved on the computer.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

023. Digital image processing

1. How is a panoramic image taken using a PSP plate captured?
2. Where does the paralleling technique require the primary beam to be projected?
3. When a periapical image is taken, where is the PSP plate/sensor centered?

4. What technique do you use when you cannot use the XCP to expose an image?

024. Mounting and inspecting images

In this lesson we discuss the steps to take once the images are scanned or saved on the computer. This includes inspecting and mounting these images in order to use them effectively for the patient's care.

Now that you have your image, it is time to inspect and mount your product. This is done before dismissing your patient in order to ensure that no retakes are needed. The table below will assist you in locating and identifying anatomical landmarks.

Mounting images

There are specific ways to mount images in the templates. First, enter the patient's correct name and information into MiPac. For PSP plates, place the letter **R** toward the incisal edge or occlusal surface so that the image does not appear backwards. All exposures are mounted and viewed from the facial aspect. Teeth should appear on the mount in the same order as they do in the mouth. Standard FMXR has 14 periapical films and four bitewing films that have some specific image identifications/landmarks shown below.

FMXR	FILM IDENTIFICATIONS
MAXILLARY MOLARS	Three roots, maxillary sinus, and maxillary tuberosity.
MAXILLARY BICUSPIDS	First bicuspid had two roots and maxillary sinus.
MAXILLARY CUSPID	Longest root and maxillary sinus.
MAXILLARY INCISORS	Maxillary sinus, maxillary suture, and nasal cavity.
MANDIBULAR MOLARS	Angle of mandible, two roots, and mandibular canal.
MANDIBULAR BICUSPID	Single root and mental foramen visible near apex.
MANDIBULAR CUSPIDS	Mental foramen visible near bicuspid.
MANDIBULAR INCISORS	Small crowns and roots.

SERIES OF 4 BITEWING (VERTICAL)	
MOLAR VIEW	BICUSPID VIEW
<ul style="list-style-type: none"> Molars of both arches Centered on 2nd molar 	<ul style="list-style-type: none"> Bicuspid of both arches Centered on second bicuspid

Preventing faulty images

Now that we have covered mounting digital radiographs, we need to discuss faulty images and some of their common causes. You must review your images and make sure they aren't faulty before dismissing the patient. Faulty images must be retaken before your patient leaves.

There are exposure errors that can reduce the quality of the radiographs you take. Remember, the goal is to take quality images so that the dentist can make an accurate diagnosis. If you have to retake an image, you are subjecting your patient to more radiation. Keep that in mind as you read and study the causes of faulty images. You need to be familiar with these so that you can make sure that they don't adversely impact your work when taking digital images.

Common Causes of Faulty Images	
Type	Cause
Foreign Images	Dentures, jewelry, glasses.
Blurred Image	Patient, film, or tube-head moving during exposures.
Double Exposure	Exposing same film twice.
CONE CUTTING	Failure of primary beam to expose entire film.
Overlapping	Improper horizontal angulation.
Elongation	Too little vertical angulation.
Foreshortening	Too much vertical angulation.
No Image	Operator and/or equipment malfunction.
Light Image	Underexposure.
Dense Or Dark Image	Overexposure.

As you can see, digital imaging is not so different than conventional radiology. Now that you have an understanding of how to take digital images, you are ready to attend to patients as a diagnostic aide!

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

024. Mounting and inspecting images

1. Maxillary molar images can be identified by what type of landmarks?
2. Mandibular molars images can be identified by what type of landmarks?
3. What causes images to appear light?
4. What is the PRIMARY reason an image does *not* appear?

Answers to Self-Test Questions

019

1. (1) CCD.
(2) Image plates.
2. CCD is composed of x-ray or light sensitive semiconductors. It is an electronic sensor available in sizes that correspond to regular x-ray film. Also, it is a piece of hard plastic with a fiber-optic cable that is directly wired to the computer. The image plates are packaged the same as the traditional film. They are similar to the intensifying screens used in extraoral radiographs.
3. To process the image plates.

4. Laser printer.
5.
 - (1) Processing time is reduced to seconds.
 - (2) Dentist can zoom in on questionable areas and adjust the contrast or density.
 - (3) Duplicates images faster.
 - (4) The requirement for chemicals and the need for silver recovery are eliminated.
6.
 - (1) Small image area of some image receptors may require twice as many films.
 - (2) Systems are very expensive.
 - (3) Images may be altered, presenting a legal issue.
 - (4) If all dental clinics do not have the same software/computer capability transfer of images cannot be accomplished.
7. Turn the x-ray machine and computer on. Drape patient with a lead apron and thyroid collar. Explain procedure to patient. Check x-ray source exposure setting. Place sensor in holder, then place protective sheath over sensor and holder. Place the sensor in patient's mouth. Place x-ray tube to area where sensor is in place. Expose image receptor. Attach plates to developing carousel and then place carousel into image scanner. Scan of image plates is initiated from computer. Computer converts analog signal from image scanner to a digital signal for storage. Image then is converted back to an analog signal for the dentist to examine it on the monitor.
8. Refer to the manufacturer's instructions for information concerning the operation of the system, equipment preparation, patient preparation, and exposure factors.
9. The digital image allows the dentist to view areas of the teeth and surrounding structures that cannot be seen with a mouth mirror and an explorer.
10. Dentist.
11. The x-ray beam strikes the sensor, an electronic charge is produced on the surface of the sensor, and the sensor sends the impulse directly to the computer which digitizes the electronic impulses.

020

1. The speed of visible light (186,000 miles/second).
2. Primary, secondary, and scatter.
3. Density relates to the degree of darkness on an image. A radiograph with high density allows little light to pass through it to your eyes. Low density will allow almost all of the transmitted light to be passed through it to be seen by the eyes. Density is an important factor of image quality as a certain amount of density is obviously needed in order for a quality diagnostic image to be formed.
4. Contrast refers to the darkness and lightness (differences in density) on various areas of the images. Contrast is important because it defines or better demonstrates the structure under examination.
5. Operator and patient.
6. As Low as Reasonably Achievable.
7. The step wedge checks exposure settings and processing.

021

1. Daily.
2. Milliamperage, kilovoltage and exposure time.
3. Eyeglasses, RPDs, or jewelry.

022

1.
 - (a) Horizontal/Vertical bitewings (BW) record crowns, alveolar crest and interproximal areas (max and man) of posterior teeth. These images detect proximal caries on posterior teeth. The difference between horizontal and vertical bitewings is that vertical bitewings measure bone level in periodontal patients.
 - (b) Periapical (per) records crowns, roots, and supporting structures of individual teeth and detects abnormalities of individual teeth and supporting structures. Periapicals can be used with a bite-tab to assemble vertical or horizontal bitewings.
 - (c) Occlusal images record large areas of the maxilla, mandible, or floor of the mouth and detect gross pathological condition and/or fractures.

2. (a) Panograph (Pano) records the complete maxilla and mandible and is used for screening or evaluation of oral pathology/injuries. This is an image that provides a view of the facial aspect of the patient.
 (b) Cephalometric records the complete maxilla and mandible and is used for screening or evaluation of oral pathology/injuries also. This is an image that provides a view of the lateral aspect of the patient.
3. An intra-oral sensor is a fiber optic cable wired to a computer. The sensor captures an image and then transmits the image to the computer. The image will appear on the computer screen within seconds of exposing the sensors. Sensors are extremely fragile and expensive but are reusable because the image is stored on a computer and not the sensor itself. The sensors can be erased and reused on different patients.
4. These imaging plates in dental imaging are flexible and coated with phosphor. They are also thinner than sensors. The PSP plates are the same size as traditional films, reusable and a wireless method for capturing dental images. After exposure, the plates are removed from the patient's mouth and placed in an electronic processor called the Scan-X. The processor's laser scans the plate and produces an image. The image is then transferred to the computer screen. A PSP plate must be erased prior to its use. PSPs are light sensitive and exposure to bright light for an extended period of time will cause your image to be faded or erased.

023

1. Directly into the MiPac viewer.
2. At a right angle to the film (perpendicular).
3. On the requested tooth.
4. Bisecting.

024

1. Three roots, maxillary sinus, and maxillary tuberosity.
2. Angle of mandible, two roots, and mandibular canal.
3. Underexposure.
4. Operator and/or equipment malfunction.

Do the unit review exercises before going to the next unit.

Unit Review Exercises

Note to Student: Consider all choices carefully, select the *best* answer to each question, and *circle* the corresponding letter. When you have completed all unit review exercises, transfer your answers to the Field Scoring Answer Sheet.

Do not return your answer sheet to the Extension Course Program (A4L).

63. (019) One type of image receptor for digital radiography is
- a. film.
 - b. a silicon chip.
 - c. an image plate.
 - d. a cathode ray tube.
64. (019) What is placed on the image scanner for processing?
- a. Image plate.
 - b. Occlusal film.
 - c. Periapical film.
 - d. Charged-coupled device.
65. (019) Which of the following is an *advantage* of digital radiography?
- a. Duplicating images are slower.
 - b. A silver recovery program is required.
 - c. Adjustments to the contrast or density can be accomplished.
 - d. A requirement of processing radiographs with chemicals is needed.
66. (019) A digital system *key element* is the
- a. sensor.
 - b. computer.
 - c. X-ray machine.
 - d. image receptor.
67. (019) Which of the following is a very important step before using a digital system for the first time?
- a. Turn on the computer.
 - b. Turn on the x-ray machine.
 - c. Explain the procedure to the patient.
 - d. Refer to manufacturer's instructions.
68. (019) What allows the dentist to view areas of the teeth?
- a. Sensor Plate.
 - b. Dental light.
 - c. Digital image.
 - d. Mouth mirror.
69. (019) Which of the following requires a processor unit to scan the digital image into the computer?
- a. Sensor.
 - b. X-ray.
 - c. PSP plate.
 - d. Digital image.

-
-
70. (020) How many types of radiation are there?
- a. One.
 - b. Two.
 - c. Three.
 - d. Four.
71. (020) Which x-ray characteristic relates to the degree of darkness on an image?
- a. Density.
 - b. Contrast.
 - c. Radiolucent.
 - d. Radiopaque.
72. (020) Which x-ray characteristic refers to the image's darkness and lightness?
- a. Density.
 - b. Contrast.
 - c. Radiolucent.
 - d. Radiopaque.
73. (020) Which x-ray characteristic is dense and does not permit the passage of radiation?
- a. Density.
 - b. Contrast.
 - c. Radiolucent.
 - d. Radiopaque.
74. (021) How many planes of reference are used for *proper patient positioning*?
- a. One.
 - b. Two.
 - c. Three.
 - d. Four.
75. (021) Which plane of reference should be parallel to the floor with the mouth slightly open for all maxillary and mandibular exposures?
- a. Occlusal plane.
 - b. Vertical plane.
 - c. Second plane.
 - d. First plane.
76. (022) In digital radiography what captures an image and transmits it to a computer?
- a. PSP.
 - b. Scan-X.
 - c. Sensors.
 - d. MiPACS.
77. (022) What is the name of the electronic processor used to produce an image from the PSP plates?
- a. Sensor.
 - b. Scan-X.
 - c. MiPACS.
 - d. Imaging software.
78. (023) Which is *not* a step in exposing and downloading an image using a digital sensor?
- a. Select template for type of digital image to be exposed.
 - b. Open digital radiology software program (MiPACS).
 - c. Double click on patient's name.
 - d. Click on Save icon.

79. (024) When mounting digital images, what should be placed toward the incisal edge or occlusal surface so that the images *do not* appear backwards?
- a. Embossed dot.
 - b. Letter —a
 - c. Nothing.
 - d. An X.
80. (024) How should the teeth appear on the mount?
- a. Same order as in the mouth.
 - b. Upside down from in the mouth.
 - c. Opposite order from in the mouth.
 - d. Backward from order in the mouth.

Glossary

Terms

adjacent—Beside, near, next to.

anode—The electrically positive terminal of an x-ray tube.

apex—The end of the tooth.

apron—A piece of clothing worn in front of the body for protection.

asepsis—The absence of all pathogenic microorganisms or process of preventing the access of microorganisms.

barrier technique—The use of rubber, plastic, paper, foil, or other fluid resistant materials to cover surfaces and protect them from contamination.

bioburden—The number and type of viable microorganisms contaminating an object. Also known as bioload or microbial load.

bioenvironmental engineering—Biomedical Service Corps function responsible for identifying and controlling occupational hazards in the workplace.

biological monitor—A bacterial endospore test designed to assess whether sterilization has actually occurred. Also known as biological spore test.

bloodborne pathogens—Pathogenic microorganisms that are present in human blood and capable of causing disease in humans. These pathogens include but are not limited to, hepatitis B virus (HBV) and human immunodeficiency virus (HIV).

Bowie-Dick test—A diagnostic test of a prevacuum sterilizer's ability to remove air from the chamber and prevent air from reentering. This is not a sterility assurance test.

chemical disinfection—The destruction or inhibition of most viruses and bacteria while in their active growth phase. The process does not necessarily kill all spores nor can it be verified by a monitor.

chemical indicator—(see process indicator)

clinical attire—Work clothes worn when treating dental patients. Clinical attire may include duty uniform, or scrub suits. Must be supplemented with personal protective equipment (PPE), such as clinic smocks, or long sleeved gowns and head covers, when exposure to blood or other potentially infectious materials (OPIM) is reasonably anticipated. Clinical attire must be laundered by the employer if it becomes contaminated with blood or OPIM.

contaminated—The presence or reasonably anticipated presence of blood or OPIM on an item or surface.

contaminated laundry—Laundry that has been contaminated or can reasonably be anticipated to have been contaminated with blood or OPIM.

contaminated sharps—Any contaminated object that can penetrate skin including, but not limited to, needles, scalpels, glass (including used anesthetic carpules), orthodontic wires and dental burs.

countertop steam sterilizer (Autoclave)—A small capacity steam autoclave that usually does not use externally generated steam. Heating elements either inside or outside the chamber are used to heat a measured amount of water which is converted to steam under pressure.

decontamination—The use of physical or chemical means to remove, inactivate, or destroy pathogens on a surface or item to the point where the surface or item is rendered safe for handling, use, or disposal.

dry heat oven—A sterilizer that relies on static dry heat at 160° for 2 hours to 170°C for 1 hour.

engineering control—Controls (e.g., sharps disposal containers, rubber dam) that isolate or remove the bloodborne pathogens hazard from the work place.

exposure incident—Specific eye, mouth, other mucous membrane, nonintact skin, or parenteral contact with blood or other infectious materials that results from the performance of an employee's duties.

exposure time—The total continuous elapsed time during which items are subjected to chemical solutions for disinfection or sterilization, or the sterilizer is operating at preselected sterilizing parameters, such as temperature and pressure.

fomite—An inanimate object or surface that acts as a reservoir or vehicle for the spread of infectious microorganisms.

gravity or downward displacement steam sterilizer (autoclave)—A type of sterilizer in which incoming steam displaces the residual air through a port or drain usually in or near the bottom of the sterilizer chamber. Typical operating temperatures are 121–123°C and 132–135°C.

infectious microorganisms—Organisms capable of producing disease in appropriate hosts.

infectious waste—(see regulated waste).

invasive procedure—A surgical entry into the tissues, cavities, organs, or the repair of traumatic injuries. This includes the manipulation, cutting, or removal of any oral or perioral tissue during which bleeding occurs or the potential for bleeding exists. Most routine restorative or related dental procedures are not considered invasive procedures.

microorganisms—Bacteria, fungi, viruses, and bacterial spores.

nosocomial infection—An infection originating in the environment of a hospital that was not present or incubating at the time of patient admission.

occupational exposure—Reasonably anticipated skin, eye, mucous membrane, or parenteral contact with blood or other potentially infectious materials that may result from the performance of an employee's duties.

other potentially infectious materials (OPIM)—Human body fluids including saliva in dental procedures, any body fluid visibly contaminated with blood, and any unfixed tissue or organ (other than intact skin) from a human (living or dead).

parenteral—Penetration of mucous membrane or skin as a result of events such as needle sticks, human bites, cuts, and abrasions.

personal protective equipment (PPE)—Specialized clothing or equipment worn by an employee to protect against a hazard. General work clothes (e.g., duty uniforms, pants, skirts or blouses) not intended to function as protection against a hazard are not considered PPE.

prevacuum steam sterilizer (Autoclave)—A type of sterilizer which relies on one or more pressure and vacuum excursions at the beginning or end of the cycle. This method of operation results in shorter cycle times due to the rapid removal of air from the chamber and the load by a vacuum system. Operating temperatures are 132–135°C.

process indicator—Chemical dyes, usually impregnated into paper strips or sterilizer tape. Used to determine whether the conditions required for sterilization are met. Conversion of process indicators does not guarantee sterility. Also known as chemical indicator, chemical monitor, or dosage indicator.

Public Health (PH)—Air Force Biomedical Services Corps (BSC) functions with responsibility for public health programs in the workplace including HBV vaccination and post exposure evaluation and follow up.

radiation—The process of emitting radiant energy in the form of waves or particles.

regulated (Medical) waste—Liquid or semi- liquid blood or other potentially infectious materials; contaminated items that would release blood or other infectious materials in a liquid or semi-liquid state if compressed; items that are caked with dried blood or other potentially infectious materials and are capable of releasing these materials during handling; contaminated sharps; and pathological and microbiological wastes containing blood or other potentially infectious materials.

saturated steam sterilization—A process which uses steam heat under pressure for a sufficient length of time to kill all forms of microorganisms. Also, commonly referred to as steam under pressure sterilization.

standard precautions—A protocol for infection control that treats all human blood and body fluids as if known to be infectious for HIV, HBV, and other bloodborne pathogens.

sterile/sterility—Free from all living microorganisms.

sterilization—Process which destroys all types and forms of microorganisms

sterilization area—The area of a health care facility designed for housing sterilization equipment and conducting sterilization procedures.

work practice controls—Controls that reduce the likelihood of exposure by altering the way one performs a task (e.g., prohibiting two- handed recapping of needles).

Abbreviations and Acronyms

ADA	American Dental Association
AFOSH	Air Force Occupational Safety and Health
AIDS	acquired immune deficiency syndrome
ALARA	As Low as Reasonably Achievable
BEE	Bioenvironmental engineering
BW	bitewings
CCD	charged-coupled device
CDC	Centers for Disease Control or career development course
CSS	Central Sterile Supply
DECS	Dental Evaluation and Consultation Service
DSC	Dental Squadron Commander
DTR	dental treatment room
EPA	Environmental Protection Agency
ETO	ethylene oxide
FDA	Food and Drug Administration
HBV	hepatitis B virus

HCI	Health-care associated infection
HCP	health care personnel
HIV	human immunodeficiency virus
HQ USAF/SG	Headquarter United States Air Force/Surgeon General
HVE	high volume evacuation
ICO	infection control officer
JCAHO	Joint Commission on Accreditation of Healthcare Organizations
kV	kilovoltage
mA	milliamperage
MTF	medical treatment facility
NIOSH	National Institute of Occupational Safety and Health
OPIM	other potentially infectious material
OSHA	Occupational Safety and Health Administration
PA	posteronanterior
PANO	Panograph
PH	public health
PID	position indicating device
PPE	personal protection equipment
PSP	phosphor imaging plates
RPD	Removable prosthesis decives
TMJ	temporomandibular joint
XCP	extension cone paralleling instruments

Student Notes

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