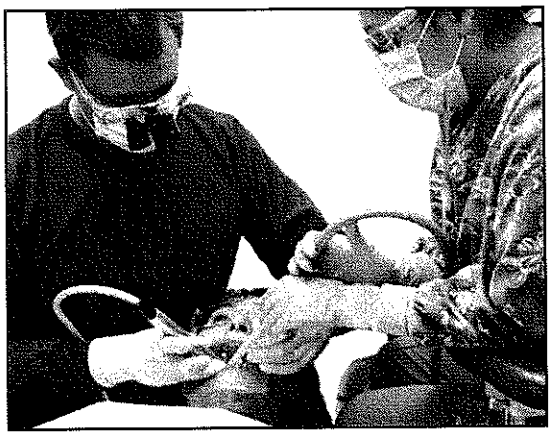
CDC

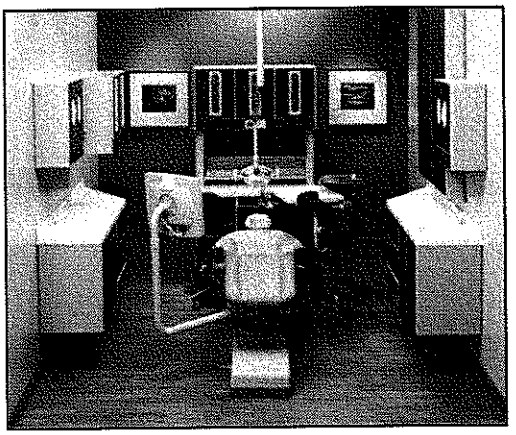
MMWR™

Morbidity and Mortality Weekly Report

Recommendations and Reports December 19, 2003 / Vol. 52 / No. RR-17

Guidelines for Infection Control in Dental Health-Care Settings — 2003





INSIDE: Continuing Education Examination

DEPARTMENT OF HEALTH AND HUMAN SERVICES
CENTERS FOR DISEASE CONTROL AND PREVENTION

The *MMWR* series of publications is published by the Epidemiology Program Office, Centers for Disease Control and Prevention (CDC), U.S. Department of Health and Human Services, Atlanta, GA 30333.

SUGGESTED CITATION

Centers for Disease Control and Prevention. Guidelines for Infection Control in Dental Health-Care Settings — 2003. MMWR 2003;52(No. RR-17):[inclusive page numbers].

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Guidelines for Infection Control in Dental Health-Care Settings — 2003

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Summary

This report consolidates previous recommendations and adds new ones for infection control in dental settings. Recommendations are provided regarding 1) educating and protecting dental health-care personnel; 2) preventing transmission of bloodborne pathogens; 3) hand hygiene; 4) personal protective equipment; 5) contact dermatitis and latex hypersensitivity; 6) sterilization and disinfection of patient-care items; 7) environmental infection control; 8) dental unit waterlines, biofilm, and water quality; and 9) special considerations (e.g., dental handpieces and other devices, radiology, parenteral medications, oral surgical procedures, and dental laboratories). These recommendations were developed in collaboration with and after review by authorities on infection control from CDC and other public agencies, academia, and private and professional organizations.

Introduction

This report consolidates recommendations for preventing and controlling infectious diseases and managing personnel health and safety concerns related to infection control in dental settings. This report 1) updates and revises previous CDC recommendations regarding infection control in dental settings (*1,2*); 2) incorporates relevant infection-control measures from other CDC guidelines; and 3) discusses concerns not addressed in previous recommendations for dentistry. These updates and additional topics include the following:

- application of standard precautions rather than universal precautions;
- work restrictions for health-care personnel (HCP) infected with or occupationally exposed to infectious diseases;
- management of occupational exposures to bloodborne pathogens, including postexposure prophylaxis (PEP) for work exposures to hepatitis B virus (HBV), hepatitis C virus (HCV); and human immunodeficiency virus (HIV);
- selection and use of devices with features designed to prevent sharps injury;
- hand-hygiene products and surgical hand antisepsis;
- contact dermatitis and latex hypersensitivity;
- sterilization of unwrapped instruments;
- dental water-quality concerns (e.g., dental unit waterline biofilms; delivery of water of acceptable biological quality for patient care; usefulness of flushing waterlines; use of sterile irrigating solutions for oral surgical procedures; handling of community boil-water advisories);
- dental radiology;
- aseptic technique for parenteral medications;
- preprocedural mouth rinsing for patients;
- oral surgical procedures;
- laser/electrosurgery plumes;
- tuberculosis (TB);
- Creutzfeldt-Jakob disease (CJD) and other prion-related diseases;
- infection-control program evaluation; and
- research considerations.

These guidelines were developed by CDC staff members in collaboration with other authorities on infection control. Draft documents were reviewed by other federal agencies and professional organizations from the fields of dental health care, public health, and hospital epidemiology and infection control. A *Federal Register* notice elicited public comments that were considered in the decision-making process. Existing guidelines and published research pertinent to dental infection-control prin-

The material in this report originated in the National Center for Chronic Disease Prevention and Health Promotion, James S. Marks, M.D., M.P.H., Director; and the Division of Oral Health, William R. Maas, D.D.S., M.P.H., Director.

ciples and practices were reviewed. Wherever possible, recommendations are based on data from well-designed scientific studies. However, only a limited number of studies have characterized risk factors and the effectiveness of prevention measures for infections associated with dental health-care practices.

Some infection-control practices routinely used by health-care practitioners cannot be rigorously examined for ethical or logistical reasons. In the absence of scientific evidence for such practices, certain recommendations are based on strong theoretical rationale, suggestive evidence, or opinions of respected authorities based on clinical experience, descriptive studies, or committee reports. In addition, some recommendations are derived from federal regulations. No recommendations are offered for practices for which insufficient scientific evidence or lack of consensus supporting their effectiveness exists.

Background

In the United States, an estimated 9 million persons work in health-care professions, including approximately 168,000 dentists, 112,000 registered dental hygienists, 218,000 dental assistants (*3*), and 53,000 dental laboratory technicians (*4*). In this report, dental health-care personnel (DHCP) refers to all paid and unpaid personnel in the dental health-care setting who might be occupationally exposed to infectious materials, including body substances and contaminated supplies, equipment, environmental surfaces, water, or air. DHCP include dentists, dental hygienists, dental assistants, dental laboratory technicians (in-office and commercial), students and trainees, contractual personnel, and other persons not directly involved in patient care but potentially exposed to infectious agents (e.g., administrative, clerical, housekeeping, maintenance, or volunteer personnel). Recommendations in this report are designed to prevent or reduce potential for disease transmission from patient to DHCP, from DHCP to patient, and from patient to patient. Although these guidelines focus mainly on outpatient, ambulatory dental health-care settings, the recommended infection-control practices are applicable to all settings in which dental treatment is provided.

Dental patients and DHCP can be exposed to pathogenic microorganisms including cytomegalovirus (CMV), HBV, HCV, herpes simplex virus types 1 and 2, HIV, *Mycobacterium tuberculosis*, staphylococci, streptococci, and other viruses and bacteria that colonize or infect the oral cavity and respiratory tract. These organisms can be transmitted in dental settings through 1) direct contact with blood, oral fluids, or other patient materials; 2) indirect contact with contaminated objects (e.g., instruments, equipment, or environmental surfaces); 3) contact of conjunctival, nasal, or oral mucosa with droplets (e.g., spatter) containing microorganisms generated from an infected person and propelled a short distance (e.g., by coughing, sneezing, or talking); and 4) inhalation of airborne microorganisms that can remain suspended in the air for long periods (*5*).

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

- a pathogenic organism of sufficient virulence and in adequate numbers to cause disease;
- a reservoir or source that allows the pathogen to survive and multiply (e.g., blood);
- a mode of transmission from the source to the host;
- a portal of entry through which the pathogen can enter the host; and
- a susceptible host (i.e., one who is not immune).

Occurrence of these events provides the chain of infection (*6*). Effective infection-control strategies prevent disease transmission by interrupting one or more links in the chain.

Previous CDC recommendations regarding infection control for dentistry focused primarily on the risk of transmission of bloodborne pathogens among DHCP and patients and use of universal precautions to reduce that risk (*1,2,7,8*). Universal precautions were based on the concept that all blood and body fluids that might be contaminated with blood should be treated as infectious because patients with bloodborne infections can be asymptomatic or unaware they are infected (*9,10*). Preventive practices used to reduce blood exposures, particularly percutaneous exposures, include 1) careful handling of sharp instruments, 2) use of rubber dams to minimize blood spattering; 3) handwashing; and 4) use of protective barriers (e.g., gloves, masks, protective eyewear, and gowns).

The relevance of universal precautions to other aspects of disease transmission was recognized, and in 1996, CDC expanded the concept and changed the term to *standard precautions*. Standard precautions integrate and expand the elements of universal precautions into a standard of care designed to protect HCP and patients from pathogens that can be spread by blood or any other body fluid, excretion, or secretion (*11*). Standard precautions apply to contact with 1) blood; 2) all body fluids, secretions, and excretions (except sweat), regardless of whether they contain blood; 3) nonintact skin; and 4) mucous membranes. Saliva has always been considered a potentially infectious material in dental infection control; thus, no operational difference exists in clinical dental practice between universal precautions and standard precautions.

In addition to standard precautions, other measures (e.g., expanded or transmission-based precautions) might be necessary to prevent potential spread of certain diseases (e.g., TB, influenza, and varicella) that are transmitted through airborne,

droplet, or contact transmission (e.g., sneezing, coughing, and contact with skin) (*11*). When acutely ill with these diseases, patients do not usually seek routine dental outpatient care. Nonetheless, a general understanding of precautions for diseases transmitted by all routes is critical because 1) some DHCP are hospital-based or work part-time in hospital settings; 2) patients infected with these diseases might seek urgent treatment at outpatient dental offices; and 3) DHCP might become infected with these diseases. Necessary transmission-based precautions might include patient placement (e.g., isolation), adequate room ventilation, respiratory protection (e.g., N-95 masks) for DHCP, or postponement of nonemergency dental procedures.

DHCP should be familiar also with the hierarchy of controls that categorizes and prioritizes prevention strategies (*12*). For bloodborne pathogens, engineering controls that eliminate or isolate the hazard (e.g., puncture-resistant sharps containers or needle-retraction devices) are the primary strategies for protecting DHCP and patients. Where engineering controls are not available or appropriate, work-practice controls that result in safer behaviors (e.g., one-hand needle recapping or not using fingers for cheek retraction while using sharp instruments or suturing), and use of personal protective equipment (PPE) (e.g., protective eyewear, gloves, and mask) can prevent exposure (*13*). In addition, administrative controls (e.g., policies, procedures, and enforcement measures targeted at reducing the risk of exposure to infectious persons) are a priority for certain pathogens (e.g., *M. tuberculosis*), particularly those spread by airborne or droplet routes.

Dental practices should develop a written infection-control program to prevent or reduce the risk of disease transmission. Such a program should include establishment and implementation of policies, procedures, and practices (in conjunction with selection and use of technologies and products) to prevent work-related injuries and illnesses among DHCP as well as health-care–associated infections among patients. The program should embody principles of infection control and occupational health, reflect current science, and adhere to relevant federal, state, and local regulations and statutes. An infection-control coordinator (e.g., dentist or other DHCP) knowledgeable or willing to be trained should be assigned responsibility for coordinating the program. The effectiveness of the infection-control program should be evaluated on a day-to-day basis and over time to help ensure that policies, procedures, and practices are useful, efficient, and successful (see Program Evaluation).

Although the infection-control coordinator remains responsible for overall management of the program, creating and maintaining a safe work environment ultimately requires the commitment and accountability of all DHCP. This report is designed to provide guidance to DHCP for preventing disease transmission in dental health-care settings, for promoting a safe working environment, and for assisting dental practices in developing and implementing infection-control programs. These programs should be followed in addition to practices and procedures for worker protection required by the Occupational Safety and Health Administration's (OSHA) standards for occupational exposure to bloodborne pathogens (*13*), including instituting controls to protect employees from exposure to blood or other potentially infectious materials (OPIM), and requiring implementation of a written exposure-control plan, annual employee training, HBV vaccinations, and postexposure follow-up (*13*). Interpretations and enforcement procedures are available to help DHCP apply this OSHA standard in practice (*14*). Also, manufacturer's Material Safety Data Sheets (MSDS) should be consulted regarding correct procedures for handling or working with hazardous chemicals (*15*).

Previous Recommendations

This report includes relevant infection-control measures from the following previously published CDC guidelines and recommendations:

- CDC. Guideline for disinfection and sterilization in health-care facilities: recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC). MMWR (in press).
- CDC. Guidelines for environmental infection control in health-care facilities: recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC). MMWR 2003;52(No. RR-10).
- CDC. Guidelines for the prevention of intravascular catheter-related infections. MMWR 2002;51(No. RR-10).
- CDC. Guideline for hand hygiene in health-care settings: recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. MMWR 2002;51 (No. RR-16).
- CDC. Updated U.S. Public Health Service guidelines for the management of occupational exposures to HBV, HCV, and HIV and recommendations for postexposure prophylaxis. MMWR 2001;50(No. RR-11).
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- CDC. Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care facilities, 1994. MMWR 1994;43(No. RR-13).
- CDC. Recommendations for preventing transmission of human immunodeficiency virus and hepatitis B virus to patients during exposure-prone invasive procedures. MMWR 1991;40(No. RR-8).
- Garner JS. CDC guideline for prevention of surgical wound infections, 1985. Supersedes guideline for prevention of surgical wound infections published in 1982. (Originally published in November 1985). Revised. Infect Control 1986;7:193–200.
- Garner JS, Favero MS. CDC guideline for handwashing and hospital environmental control, 1985. Infect Control 1986;7:231–43.

Selected Definitions

Alcohol-based hand rub: An alcohol-containing preparation designed for reducing the number of viable microorganisms on the hands.

Antimicrobial soap: A detergent containing an antiseptic agent.

Antiseptic: A germicide used on skin or living tissue for the purpose of inhibiting or destroying microorganisms (e.g., alcohols, chlorhexidine, chlorine, hexachlorophene, iodine, chloroxylenol [PCMX], quaternary ammonium compounds, and triclosan).

Bead sterilizer: A device using glass beads 1.2–1.5 mm diameter and temperatures 217°C–232°C for brief exposures (e.g., 45 seconds) to inactivate microorganisms. (This term is actually a misnomer because it has not been cleared by the Food and Drug Administration [FDA] as a sterilizer).

Bioburden: Microbiological load (i.e., number of viable organisms in or on an object or surface) or organic material on a surface or object before decontamination, or sterilization. Also known as *bioload* or *microbial load.*

Colony-forming unit (CFU): The minimum number (i.e., tens of millions) of separable cells on the surface of or in semisolid agar medium that give rise to a visible colony of progeny. CFUs can consist of pairs, chains, clusters, or as single cells and are often expressed as colony-forming units per milliliter (CFUs/mL).

Decontamination: Use of physical or chemical means to remove, inactivate, or destroy pathogens on a surface or item so that they are no longer capable of transmitting infectious particles and the surface or item is rendered safe for handling, use, or disposal.

Dental treatment water: Nonsterile water used during dental treatment, including irrigation of nonsurgical operative sites and cooling of high-speed rotary and ultrasonic instruments.

Disinfectant: A chemical agent used on inanimate objects (e.g., floors, walls, or sinks) to destroy virtually all recognized pathogenic microorganisms, but not necessarily all microbial forms (e.g., bacterial endospores). The U.S. Environmental Protection Agency (EPA) groups disinfectants on the basis of whether the product label claims limited, general, or hospital disinfectant capabilities.

Disinfection: Destruction of pathogenic and other kinds of microorganisms by physical or chemical means. Disinfection is less lethal than sterilization, because it destroys the majority of recognized pathogenic microorganisms, but not necessarily all microbial forms (e.g., bacterial spores). Disinfection does not ensure the degree of safety associated with sterilization processes.

Droplet nuclei: Particles $\leq$5 µm in diameter formed by dehydration of airborne droplets containing microorganisms that can remain suspended in the air for long periods of time.

Droplets: Small particles of moisture (e.g., spatter) generated when a person coughs or sneezes, or when water is converted to a fine mist by an aerator or shower head. These particles, intermediate in size between drops and droplet nuclei, can contain infectious microorganisms and tend to quickly settle from the air such that risk of disease transmission is usually limited to persons in close proximity to the droplet source.

Endotoxin: The lipopolysaccharide of gram-negative bacteria, the toxic character of which resides in the lipid protein. Endotoxins can produce pyrogenic reactions in persons exposed to their bacterial component.

Germicide: An agent that destroys microorganisms, especially pathogenic organisms. Terms with the same suffix (e.g., *virucide, fungicide, bactericide, tuberculocide,* and *sporicide*) indi-

cate agents that destroy the specific microorganism identified by the prefix. Germicides can be used to inactivate microorganisms in or on living tissue (i.e., antiseptics) or on environmental surfaces (i.e., disinfectants).

Hand hygiene: General term that applies to handwashing, antiseptic handwash, antiseptic hand rub, or surgical hand antisepsis.

Health-care–associated infection: Any infection associated with a medical or surgical intervention. The term *health-care–associated* replaces *nosocomial*, which is limited to adverse infectious outcomes occurring in hospitals.

Hepatitis B immune globulin (HBIG): Product used for prophylaxis against HBV infection. HBIG is prepared from plasma containing high titers of hepatitis B surface antibody (anti-HBs) and provides protection for 3–6 mos.

Hepatitis B surface antigen (HBsAg): Serologic marker on the surface of HBV detected in high levels during acute or chronic hepatitis. The body normally produces antibodies to surface antigen as a normal immune response to infection.

Hepatitis B e antigen (HBeAg): Secreted product of the nucleocapsid gene of HBV found in serum during acute and chronic HBV infection. Its presence indicates that the virus is replicating and serves as a marker of increased infectivity.

Hepatitis B surface antibody (anti-HBs): Protective antibody against HBsAg. Presence in the blood can indicate past infection with, and immunity to, HBV, or immune response from hepatitis B vaccine.

Heterotrophic bacteria: Those bacteria requiring an organic carbon source for growth (i.e., deriving energy and carbon from organic compounds).

High-level disinfection: Disinfection process that inactivates vegetative bacteria, mycobacteria, fungi, and viruses but not necessarily high numbers of bacterial spores. FDA further defines a high-level disinfectant as a sterilant used for a shorter contact time.

Hospital disinfectant: Germicide registered by EPA for use on inanimate objects in hospitals, clinics, dental offices, and other medical-related facilities. Efficacy is demonstrated against *Salmonella choleraesuis*, *Staphylococcus aureus*, and *Pseudomonas aeruginosa*.

Iatrogenic: Induced inadvertently by HCP, medical (including dental) treatment, or diagnostic procedures. Used particularly in reference to an infectious disease or other complication of treatment.

Immunization: Process by which a person becomes immune, or protected against a disease. Vaccination is defined as the process of administering a killed or weakened infectious organism or a toxoid; however, vaccination does not always result in immunity.

Implantable device: Device placed into a surgically or naturally formed cavity of the human body and intended to remain there for ≥30 days.

Independent water reservoir: Container used to hold water or other solutions and supply it to handpieces and air and water syringes attached to a dental unit. The independent reservoir, which isolates the unit from the public water system, can be provided as original equipment or as a retrofitted device.

Intermediate-level disinfection: Disinfection process that inactivates vegetative bacteria, the majority of fungi, mycobacteria, and the majority of viruses (particularly enveloped viruses) but not bacterial spores.

Intermediate-level disinfectant: Liquid chemical germicide registered with EPA as a hospital disinfectant and with a label claim of potency as tuberculocidal (Appendix A).

Latex: Milky white fluid extracted from the rubber tree *Hevea brasiliensis* that contains the rubber material cis-1,4 polyisoprene.

Low-level disinfection: Process that inactivates the majority of vegetative bacteria, certain fungi, and certain viruses, but cannot be relied on to inactivate resistant microorganisms (e.g., mycobacteria or bacterial spores).

Low-level disinfectant: Liquid chemical germicide registered with EPA as a hospital disinfectant. OSHA requires low-level hospital disinfectants also to have a label claim for potency against HIV and HBV if used for disinfecting clinical contact surfaces (Appendix A).

Microfilter: Membrane filter used to trap microorganisms suspended in water. Filters are usually installed on dental unit waterlines as a retrofit device. Microfiltration commonly occurs at a filter pore size of 0.03–10 µm. Sediment filters commonly found in dental unit water regulators have pore sizes of 20–90 µm and do not function as microbiological filters.

Nosocomial: Infection acquired in a hospital as a result of medical care.

Occupational exposure: Reasonably anticipated skin, eye, mucous membrane, or parenteral contact with blood or OPIM that can result from the performance of an employee's duties.

OPIM: Other potentially infectious materials. OPIM is an OSHA term that refers to 1) body fluids including semen, vaginal secretions, cerebrospinal fluid, synovial fluid, pleural fluid, pericardial fluid, peritoneal fluid, amniotic fluid, saliva in dental procedures; any body fluid visibly contaminated with blood; and all body fluids in situations where differentiating between body fluids is difficult or impossible; 2) any unfixed tissue or organ (other than intact skin) from a human (living or dead); and 3) HIV-containing cell or tissue cultures, organ

cultures; HIV- or HBV-containing culture medium or other solutions; and blood, organs, or other tissues from experimental animals infected with HIV or HBV.

Parenteral: Means of piercing mucous membranes or skin barrier through such events as needlesticks, human bites, cuts, and abrasions.

Persistent activity: Prolonged or extended activity that prevents or inhibits proliferation or survival of microorganisms after application of a product. This activity can be demonstrated by sampling a site minutes or hours after application and demonstrating bacterial antimicrobial effectiveness when compared with a baseline level. Previously, this property was sometimes termed *residual activity*.

Prion: Protein particle lacking nucleic acid that has been implicated as the cause of certain neurodegenerative diseases (e.g., scrapie, CJD, and bovine spongiform encephalopathy [BSE]).

Retraction: Entry of oral fluids and microorganisms into waterlines through negative water pressure.

Seroconversion: The change of a serological test from negative to positive indicating the development of antibodies in response to infection or immunization.

Sterile: Free from all living microorganisms; usually described as a probability (e.g., the probability of a surviving microorganism being 1 in 1 million).

Sterilization: Use of a physical or chemical procedure to destroy all microorganisms including substantial numbers of resistant bacterial spores.

Surfactants: Surface-active agents that reduce surface tension and help cleaning by loosening, emulsifying, and holding soil in suspension, to be more readily rinsed away.

Ultrasonic cleaner: Device that removes debris by a process called cavitation, in which waves of acoustic energy are propagated in aqueous solutions to disrupt the bonds that hold particulate matter to surfaces.

Vaccination: See immunization.

Vaccine: Product that induces immunity, therefore protecting the body from the disease. Vaccines are administered through needle injections, by mouth, and by aerosol.

Washer-disinfector: Automatic unit that cleans and thermally disinfects instruments, by using a high-temperature cycle rather than a chemical bath.

Wicking: Absorption of a liquid by capillary action along a thread or through the material (e.g., penetration of liquids through undetected holes in a glove).

Review of Science Related to Dental Infection Control

Personnel Health Elements of an Infection-Control Program

A protective health component for DHCP is an integral part of a dental practice infection-control program. The objectives are to educate DHCP regarding the principles of infection control, identify work-related infection risks, institute preventive measures, and ensure prompt exposure management and medical follow-up. Coordination between the dental practice's infection-control coordinator and other qualified health-care professionals is necessary to provide DHCP with appropriate services. Dental programs in institutional settings, (e.g., hospitals, health centers, and educational institutions) can coordinate with departments that provide personnel health services. However, the majority of dental practices are in ambulatory, private settings that do not have licensed medical staff and facilities to provide complete on-site health service programs. In such settings, the infection-control coordinator should establish programs that arrange for site-specific infection-control services from external health-care facilities and providers before DHCP are placed at risk for exposure. Referral arrangements can be made with qualified health-care professionals in an occupational health program of a hospital, with educational institutions, or with health-care facilities that offer personnel health services.

Education and Training

Personnel are more likely to comply with an infection-control program and exposure-control plan if they understand its rationale (*5,13,16*). Clearly written policies, procedures, and guidelines can help ensure consistency, efficiency, and effective coordination of activities. Personnel subject to occupational exposure should receive infection-control training on initial assignment, when new tasks or procedures affect their occupational exposure, and at a minimum, annually (*13*). Education and training should be appropriate to the assigned duties of specific DHCP (e.g., techniques to prevent cross-contamination or instrument sterilization). For DHCP who perform tasks or procedures likely to result in occupational exposure to infectious agents, training should include 1) a description of their exposure risks; 2) review of prevention strategies and infection-control policies and procedures; 3) discussion regarding how to manage work-related illness and injuries, including PEP; and 4) review of work restrictions for the exposure or infection. Inclusion of DHCP with minimal exposure risks (e.g., administrative employees) in education and training programs might enhance facilitywide understand-

ing of infection-control principles and the importance of the program. Educational materials should be appropriate in content and vocabulary for each person's educational level, literacy, and language, as well as be consistent with existing federal, state, and local regulations (*5,13*).

Immunization Programs

DHCP are at risk for exposure to, and possible infection with, infectious organisms. Immunizations substantially reduce both the number of DHCP susceptible to these diseases and the potential for disease transmission to other DHCP and patients (*5,17*). Thus, immunizations are an essential part of prevention and infection-control programs for DHCP, and a comprehensive immunization policy should be implemented for all dental health-care facilities (*17,18*). The Advisory Committee on Immunization Practices (ACIP) provides national guidelines for immunization of HCP, which includes DHCP (*17*). Dental practice immunization policies should incorporate current state and federal regulations as well as recommendations from the U.S. Public Health Service and professional organizations (*17*) (Appendix B).

On the basis of documented health-care–associated transmission, HCP are considered to be at substantial risk for acquiring or transmitting hepatitis B, influenza, measles, mumps, rubella, and varicella. All of these diseases are vaccine-preventable. ACIP recommends that all HCP be vaccinated or have documented immunity to these diseases (*5,17*). ACIP does not recommend routine immunization of HCP against TB (i.e., inoculation with bacille Calmette-Guérin vaccine) or hepatitis A (*17*). No vaccine exists for HCV. ACIP guidelines also provide recommendations regarding immunization of HCP with special conditions (e.g., pregnancy, HIV infection, or diabetes) (*5,17*).

Immunization of DHCP before they are placed at risk for exposure remains the most efficient and effective use of vaccines in health-care settings. Some educational institutions and infection-control programs provide immunization schedules for students and DHCP. OSHA requires that employers make hepatitis B vaccination available to all employees who have potential contact with blood or OPIM. Employers are also required to follow CDC recommendations for vaccinations, evaluation, and follow-up procedures (*13*). Nonpatient-care staff (e.g., administrative or housekeeping) might be included, depending on their potential risk of coming into contact with blood or OPIM. Employers are also required to ensure that employees who decline to accept hepatitis B vaccination sign an appropriate declination statement (*13*). DHCP unable or unwilling to be vaccinated as required or recommended should be educated regarding their exposure risks, infection-control policies and procedures for the facility, and the management of work-related illness and work restrictions (if appropriate) for exposed or infected DHCP.

Exposure Prevention and Postexposure Management

Avoiding exposure to blood and OPIM, as well as protection by immunization, remain primary strategies for reducing occupationally acquired infections, but occupational exposures can still occur (*19*). A combination of standard precautions, engineering, work practice, and administrative controls is the best means to minimize occupational exposures. Written policies and procedures to facilitate prompt reporting, evaluation, counseling, treatment, and medical follow-up of all occupational exposures should be available to all DHCP. Written policies and procedures should be consistent with federal, state, and local requirements addressing education and training, postexposure management, and exposure reporting (see Preventing Transmission of Bloodborne Pathogens).

DHCP who have contact with patients can also be exposed to persons with infectious TB, and should have a baseline tuberculin skin test (TST), preferably by using a two-step test, at the beginning of employment (*20*). Thus, if an unprotected occupational exposure occurs, TST conversions can be distinguished from positive TST results caused by previous exposures (*20,21*). The facility's level of TB risk will determine the need for routine follow-up TSTs (see Special Considerations).

Medical Conditions, Work-Related Illness, and Work Restrictions

DHCP are responsible for monitoring their own health status. DHCP who have acute or chronic medical conditions that render them susceptible to opportunistic infection should discuss with their personal physicians or other qualified authority whether the condition might affect their ability to safely perform their duties. However, under certain circumstances, health-care facility managers might need to exclude DHCP from work or patient contact to prevent further transmission of infection (*22*). Decisions concerning work restrictions are based on the mode of transmission and the period of infectivity of the disease (*5*) (Table 1). Exclusion policies should 1) be written, 2) include a statement of authority that defines who can exclude DHCP (e.g., personal physicians), and 3) be clearly communicated through education and training. Policies should also encourage DHCP to report illnesses or exposures without jeopardizing wages, benefits, or job status.

With increasing concerns regarding bloodborne pathogens and introduction of universal precautions, use of latex gloves among HCP has increased markedly (*7,23*). Increased use of these gloves has been accompanied by increased reports of allergic reactions to natural rubber latex among HCP, DHCP, and patients

TABLE 1. Suggested work restrictions for health-care personnel infected with or exposed to major infectious diseases in health-care settings, in the absence of state and local regulations*

Disease/problem	Work restriction	Duration
Conjunctivitis	Restrict from patient contact and contact with patient's environment.	Until discharge ceases
Cytomegalovirus infection	No restriction	
Diarrheal disease		
Acute stage (diarrhea with other symptoms)	Restrict from patient contact, contact with patient's environment, and food-handling.	Until symptoms resolve
Convalescent stage, *Salmonella* species	Restrict from care of patients at high risk.	Until symptoms resolve; consult with local and state health authorities regarding need for negative stool cultures
Enteroviral infection	Restrict from care of infants, neonates, and immunocompromised patients and their environments.	Until symptoms resolve
Hepatitis A	Restrict from patient contact, contact with patient's environment, and food-handing.	Until 7 days after onset of jaundice
Hepatitis B		
Personnel with acute or chronic hepatitis B surface antigenemia who do not perform exposure-prone procedures	No restriction†; refer to state regulations. Standard precautions should always be followed.	
Personnel with acute or chronic hepatitis B e antigenemia who perform exposure-prone procedures	Do not perform exposure-prone invasive procedures until counsel from a review panel has been sought; panel should review and recommend procedures that personnel can perform, taking into account specific procedures as well as skill and technique. Standard precautions should always be observed. Refer to state and local regulations or recommendations.	Until hepatitis B e antigen is negative
Hepatitis C	No restrictions on professional activity.† HCV-positive health-care personnel should follow aseptic technique and standard precautions.	
Herpes simplex		
Genital	No restriction	
Hands (herpetic whitlow)	Restrict from patient contact and contact with patient's environment.	Until lesions heal
Orofacial	Evaluate need to restrict from care of patients at high risk.	
Human immunodeficiency virus; personnel who perform exposure-prone procedures	Do not perform exposure-prone invasive procedures until counsel from an expert review panel has been sought; panel should review and recommend procedures that personnel can perform, taking into account specific procedures as well as skill and technique. Standard precautions should always be observed. Refer to state and local regulations or recommendations.	
Measles		
Active	Exclude from duty	Until 7 days after the rash appears
Postexposure (susceptible personnel)	Exclude from duty	From fifth day after first exposure through twenty-first day after last exposure, or 4 days after rash appears
Meningococcal infection	Exclude from duty	Until 24 hours after start of effective therapy
Mumps		
Active	Exclude from duty	Until 9 days after onset of parotitis
Postexposure (susceptible personnel)	Exclude from duty	From twelfth day after first exposure through twenty-sixth day after last exposure, or until 9 days after onset of parotitis

Source: Adapted from Bolyard EA, Hospital Infection Control Practices Advisory Committee. Guidelines for infection control in health care personnel, 1998. Am J Infect Control 1998;26:289–354.

* Modified from recommendations of the Advisory Committee on Immunization Practices (ACIP).

† Unless epidemiologically linked to transmission of infection.

§ Those susceptible to varicella and who are at increased risk of complications of varicella (e.g., neonates and immunocompromised persons of any age).

¶ Patients at high risk as defined by ACIP for complications of influenza.

TABLE 1. (*Continued*) Suggested work restrictions for health-care personnel infected with or exposed to major infectious diseases in health-care settings, in the absence of state and local regulations*

Disease/problem	Work restriction	Duration
Pediculosis	Restrict from patient contact	Until treated and observed to be free of adult and immature lice
Pertussis		
Active	Exclude from duty	From beginning of catarrhal stage through third week after onset of paroxysms, or until 5 days after start of effective antibiotic therapy
Postexposure (asymptomatic personnel)	No restriction, prophylaxis recommended	
Postexposure (symptomatic personnel)	Exclude from duty	Until 5 days after start of effective antibiotic therapy
Rubella		
Active	Exclude from duty	Until 5 days after rash appears
Postexposure (susceptible personnel)	Exclude from duty	From seventh day after first exposure through twenty-first day after last exposure
Staphylococcus aureus infection		
Active, draining skin lesions	Restrict from contact with patients and patient's environment or food handling.	Until lesions have resolved
Carrier state	No restriction unless personnel are epidemiologically linked to transmission of the organism	
Streptococcal infection, group A	Restrict from patient care, contact with patient's environment, and food-handling.	Until 24 hours after adequate treatment started
Tuberculosis		
Active disease	Exclude from duty	Until proved noninfectious
PPD converter	No restriction	
Varicella (chicken pox)		
Active	Exclude from duty	Until all lesions dry and crust
Postexposure (susceptible personnel)	Exclude from duty	From tenth day after first exposure through twenty-first day (twenty-eighth day if varicella-zoster immune globulin [VZIG] administered) after last exposure.
Zoster (shingles)		
Localized, in healthy person	Cover lesions, restrict from care of patients[§] at high risk	Until all lesions dry and crust
Generalized or localized in immunosuppressed person	Restrict from patient contact	Until all lesions dry and crust
Postexposure (susceptible personnel)	Restrict from patient contact	From tenth day after first exposure through twenty-first day (twenty-eighth day if VZIG administered) after last exposure; or, if varicella occurs, when lesions crust and dry
Viral respiratory infection, acute febrile	Consider excluding from the care of patients at high risk[¶] or contact with such patients' environments during community outbreak of respiratory syncytial virus and influenza	Until acute symptoms resolve

Source: Adapted from Bolyard EA, Hospital Infection Control Practices Advisory Committee. Guidelines for infection control in health care personnel, 1998. Am J Infect Control 1998;26:289–354.
* Modified from recommendations of the Advisory Committee on Immunization Practices (ACIP).
† Unless epidemiologically linked to transmission of infection.
§ Those susceptible to varicella and who are at increased risk of complications of varicella (e.g., neonates and immunocompromised persons of any age).
¶ Patients at high risk as defined by ACIP for complications of influenza.

(*24–30*), as well as increased reports of irritant and allergic contact dermatitis from frequent and repeated use of hand-hygiene products, exposure to chemicals, and glove use.

DHCP should be familiar with the signs and symptoms of latex sensitivity (*5,31–33*). A physician should evaluate DHCP exhibiting symptoms of latex allergy, because further exposure could result in a serious allergic reaction. A diagnosis is made through medical history, physical examination, and diagnostic tests. Procedures should be in place for minimizing latex-related health problems among DHCP and patients while protecting them from infectious materials. These procedures should include 1) reducing exposures to latex-containing materials by using appropriate work practices, 2) training and educating DHCP, 3) monitoring symptoms, and 4) substituting nonlatex products where appropriate (*32*) (see Contact Dermatitis and Latex Hypersensitivity).

Maintenance of Records, Data Management, and Confidentiality

The health status of DHCP can be monitored by maintaining records of work-related medical evaluations, screening tests, immunizations, exposures, and postexposure management. Such records must be kept in accordance with all applicable state and federal laws. Examples of laws that might apply include the Privacy Rule of the Health Insurance Portability and Accountability Act (HIPAA) of 1996, 45 CFR 160 and 164, and the OSHA Occupational Exposure to Bloodborne Pathogens; Final Rule 29 CFR 1910.1030(h)(1)(i–iv) (*34,13*). The HIPAA Privacy Rule applies to covered entities, including certain defined health providers, health-care clearinghouses, and health plans. OSHA requires employers to ensure that certain information contained in employee medical records is 1) kept confidential; 2) not disclosed or reported without the employee's express written consent to any person within or outside the workplace except as required by the OSHA standard; and 3) maintained by the employer for at least the duration of employment plus 30 years. Dental practices that coordinate their infection-control program with off-site providers might consult OSHA's Bloodborne Pathogen standard and employee Access to Medical and Exposure Records standard, as well as other applicable local, state, and federal laws, to determine a location for storing health records (*13,35*).

Preventing Transmission of Bloodborne Pathogens

Although transmission of bloodborne pathogens (e.g., HBV, HCV, and HIV) in dental health-care settings can have serious consequences, such transmission is rare. Exposure to infected blood can result in transmission from patient to DHCP, from DHCP to patient, and from one patient to another. The opportunity for transmission is greatest from patient to DHCP, who frequently encounter patient blood and blood-contaminated saliva during dental procedures.

Since 1992, no HIV transmission from DHCP to patients has been reported, and the last HBV transmission from DHCP to patients was reported in 1987. HCV transmission from DHCP to patients has not been reported. The majority of DHCP infected with a bloodborne virus do not pose a risk to patients because they do not perform activities meeting the necessary conditions for transmission. For DHCP to pose a risk for bloodborne virus transmission to patients, DHCP must 1) be viremic (i.e., have infectious virus circulating in the bloodstream); 2) be injured or have a condition (e.g., weeping dermatitis) that allows direct exposure to their blood or other infectious body fluids; and 3) enable their blood or infectious body fluid to gain direct access to a patient's wound, traumatized tissue, mucous membranes, or similar portal of entry. Although an infected DHCP might be viremic, unless the second and third conditions are also met, transmission cannot occur.

The risk of occupational exposure to bloodborne viruses is largely determined by their prevalence in the patient population and the nature and frequency of contact with blood and body fluids through percutaneous or permucosal routes of exposure. The risk of infection after exposure to a bloodborne virus is influenced by inoculum size, route of exposure, and susceptibility of the exposed HCP (*12*). The majority of attention has been placed on the bloodborne pathogens HBV, HCV, and HIV, and these pathogens present different levels of risk to DHCP.

Hepatitis B Virus

HBV is a well-recognized occupational risk for HCP (*36,37*). HBV is transmitted by percutaneous or mucosal exposure to blood or body fluids of a person with either acute or chronic HBV infection. Persons infected with HBV can transmit the virus for as long as they are HBsAg-positive. The risk of HBV transmission is highly related to the HBeAg status of the source person. In studies of HCP who sustained injuries from needles contaminated with blood containing HBV, the risk of developing clinical hepatitis if the blood was positive for both HBsAg and HBeAg was 22%–31%; the risk of developing serologic evidence of HBV infection was 37%–62% (*19*). By comparison, the risk of developing clinical hepatitis from a needle contaminated with HBsAg-positive, HBeAg-negative blood was 1%–6%, and the risk of developing serologic evidence of HBV infection, 23%–37% (*38*).

Blood contains the greatest proportion of HBV infectious particle titers of all body fluids and is the most critical vehicle of transmission in the health-care setting. HBsAg is also found in multiple other body fluids, including breast milk, bile, cerebrospinal fluid, feces, nasopharyngeal washings, saliva, semen, sweat, and synovial fluid. However, the majority of body fluids are not efficient vehicles for transmission because they contain low quantities of infectious HBV, despite the presence of HBsAg (*19*). The concentration of HBsAg in body fluids can be 100–1,000-fold greater than the concentration of infectious HBV particles (*39*).

Although percutaneous injuries are among the most efficient modes of HBV transmission, these exposures probably account for only a minority of HBV infections among HCP. In multiple investigations of nosocomial hepatitis B outbreaks, the majority of infected HCP could not recall an overt percutaneous injury (*40,41*), although in certain studies, approximately one third of infected HCP recalled caring for a patient who was HBsAg-positive (*42,43*). In addition, HBV has been demonstrated to survive in dried blood at room temperature on environmental surfaces for ≤1 week (*44*). Thus, HBV infections that occur in HCP with no history of nonoccupational exposure or occupational percutaneous injury might have resulted from direct or indirect blood or body fluid exposures that inoculated HBV into cutaneous scratches, abrasions, burns, other lesions, or on mucosal surfaces (*45–47*). The potential for HBV transmission through contact with environmental surfaces has been demonstrated in investigations of HBV outbreaks among patients and HCP in hemodialysis units (*48–50*).

Since the early 1980s, occupational infections among HCP have declined because of vaccine use and adherence to universal precautions (*51*). Among U.S. dentists, >90% have been vaccinated, and serologic evidence of past HBV infection decreased from prevaccine levels of 14% in 1972 to approximately 9% in 1992 (*52*). During 1993–2001, levels remained relatively unchanged (Chakwan Siew, Ph.D., American Dental Association, Chicago, Illinois, personal communication, June 2003). Infection rates can be expected to decline further as vaccination rates remain high among young dentists and as older dentists with lower vaccination rates and higher rates of infection retire.

Although the potential for transmission of bloodborne infections from DHCP to patients is considered limited (*53–55*), precise risks have not been quantified by carefully designed epidemiologic studies (*53,56,57*). Reports published during 1970–1987 describe nine clusters in which patients were thought to be infected with HBV through treatment by an infected DHCP (*58–67*). However, transmission of HBV from dentist to patient has not been reported since 1987, possibly reflecting such factors as 1) adoption of universal precautions, 2) routine glove use, 3) increased levels of immunity as a result of hepatitis B vaccination of DHCP, 4) implementation of the 1991 OSHA bloodborne pathogen standard (*68*), and 5) incomplete ascertainment and reporting. Only one case of patient-to-patient transmission of HBV in the dental setting has been documented (CDC, unpublished data, 2003). In this case, appropriate office infection-control procedures were being followed, and the exact mechanism of transmission was undetermined.

Because of the high risk of HBV infection among HCP, DHCP who perform tasks that might involve contact with blood, blood-contaminated body substances, other body fluids, or sharps should be vaccinated (*2,13,17,19,69*). Vaccination can protect both DHCP and patients from HBV infection and, whenever possible, should be completed when dentists or other DHCP are in training and before they have contact with blood.

Prevaccination serological testing for previous infection is not indicated, although it can be cost-effective where prevalence of infection is expected to be high in a group of potential vacinees (e.g., persons who have emigrated from areas with high rates of HBV infection). DHCP should be tested for anti-HBs 1–2 months after completion of the 3-dose vaccination series (*17*). DHCP who do not develop an adequate antibody response (i.e., anti-HBs <10 mIU/mL) to the primary vaccine series should complete a second 3-dose vaccine series or be evaluated to determine if they are HBsAg-positive (*17*). Revaccinated persons should be retested for anti-HBs at the completion of the second vaccine series. Approximately half of nonresponders to the primary series will respond to a second 3-dose series. If no antibody response occurs after the second series, testing for HBsAg should be performed (*17*). Persons who prove to be HBsAg-positive should be counseled regarding how to prevent HBV transmission to others and regarding the need for medical evaluation. Nonresponders to vaccination who are HBsAg-negative should be considered susceptible to HBV infection and should be counseled regarding precautions to prevent HBV infection and the need to obtain HBIG prophylaxis for any known or probable parenteral exposure to HBsAg-positive blood.

Vaccine-induced antibodies decline gradually over time, and 60% of persons who initially respond to vaccination will lose detectable antibodies over 12 years. Even so, immunity continues to prevent clinical disease or detectable viral infection (*17*). Booster doses of vaccine and periodic serologic testing to monitor antibody concentrations after completion of the vaccine series are not necessary for vaccine responders (*17*).

Hepatitis D Virus

An estimated 4% of persons with acute HBV infection are also infected with hepatitis Delta virus (HDV). Discovered in 1977, HDV is a defective bloodborne virus requiring the presence of HBV to replicate. Patients coinfected with HBV and HDV have substantially higher mortality rates than those infected with HBV alone. Because HDV infection is dependent on HBV for replication, immunization to prevent HBV infection, through either pre- or postexposure prophylaxis, can also prevent HDV infection (*70*).

Hepatitis C Virus

Hepatitis C virus appears not to be transmitted efficiently through occupational exposures to blood. Follow-up studies of HCP exposed to HCV-infected blood through percutaneous or other sharps injuries have determined a low incidence of seroconversion (mean: 1.8%; range, 0%–7%) (*71–74*). One study determined transmission occurred from hollow-bore needles but not other sharps (*72*). Although these studies have not documented seroconversion associated with mucous membrane or nonintact skin exposure, at least two cases of HCV transmission from a blood splash to the conjunctiva (*75,76*) and one case of simultaneous transmission of HCV and HIV after nonintact skin exposure have been reported (*77*).

Data are insufficient to estimate the occupational risk of HCV infection among HCP, but the majority of studies indicate the prevalence of HCV infection among dentists, surgeons, and hospital-based HCP is similar to that among the general population, approximately 1%–2% (*78–86*). In a study that evaluated risk factors for infection, a history of unintentional needlesticks was the only occupational risk factor independently associated with HCV infection (*80*).

No studies of transmission from HCV-infected DHCP to patients have been reported, and the risk for such transmission appears limited. Multiple reports have been published describing transmission from HCV-infected surgeons, which apparently occurred during performance of invasive procedures; the overall risk for infection averaged 0.17% (*87–90*).

Human Immunodeficiency Virus

In the United States, the risk of HIV transmission in dental settings is extremely low. As of December 2001, a total of 57 cases of HIV seroconversion had been documented among HCP, but none among DHCP, after occupational exposure to a known HIV-infected source (*91*). Transmission of HIV to six patients of a single dentist with AIDS has been reported, but the mode of transmission could not be determined (*2,92,93*). As of September 30, 1993, CDC had information regarding test results of >22,000 patients of 63 HIV-infected HCP, including 33 dentists or dental students (*55,93*). No additional cases of transmission were documented.

Prospective studies worldwide indicate the average risk of HIV infection after a single percutaneous exposure to HIV-infected blood is 0.3% (range: 0.2%–0.5%) (*94*). After an exposure of mucous membranes in the eye, nose, or mouth, the risk is approximately 0.1% (*76*). The precise risk of transmission after skin exposure remains unknown but is believed to be even smaller than that for mucous membrane exposure.

Certain factors affect the risk of HIV transmission after an occupational exposure. Laboratory studies have determined if needles that pass through latex gloves are solid rather than hollow-bore, or are of small gauge (e.g., anesthetic needles commonly used in dentistry), they transfer less blood (*36*). In a retrospective case-control study of HCP, an increased risk for HIV infection was associated with exposure to a relatively large volume of blood, as indicated by a deep injury with a device that was visibly contaminated with the patient's blood, or a procedure that involved a needle placed in a vein or artery (*95*). The risk was also increased if the exposure was to blood from patients with terminal illnesses, possibly reflecting the higher titer of HIV in late-stage AIDS.

Exposure Prevention Methods

Avoiding occupational exposures to blood is the primary way to prevent transmission of HBV, HCV, and HIV, to HCP in health-care settings (*19,96,97*). Exposures occur through percutaneous injury (e.g., a needlestick or cut with a sharp object), as well as through contact between potentially infectious blood, tissues, or other body fluids and mucous membranes of the eye, nose, mouth, or nonintact skin (e.g., exposed skin that is chapped, abraded, or shows signs of dermatitis).

Observational studies and surveys indicate that percutaneous injuries among general dentists and oral surgeons occur less frequently than among general and orthopedic surgeons and have decreased in frequency since the mid-1980s (*98–102*). This decline has been attributed to safer work practices, safer instrumentation or design, and continued DHCP education (*103,104*). Percutaneous injuries among DHCP usually 1) occur outside the patient's mouth, thereby posing less risk for recontact with patient tissues; 2) involve limited amounts of blood; and 3) are caused by burs, syringe needles, laboratory knives, and other sharp instruments (*99–102,105,106*). Injuries among oral surgeons might occur more frequently during fracture reductions using wires (*104,107*). Experience, as measured by years in practice, does not appear to affect the risk of injury among general dentists or oral surgeons (*100,104,107*).

The majority of exposures in dentistry are preventable, and methods to reduce the risk of blood contacts have included use of standard precautions, use of devices with features engineered to prevent sharp injuries, and modifications of work practices. These approaches might have contributed to the decrease in percutaneous injuries among dentists during recent years (*98–100,103*). However, needlesticks and other blood contacts continue to occur, which is a concern because percutaneous injuries pose the greatest risk of transmission.

Standard precautions include use of PPE (e.g., gloves, masks, protective eyewear or face shield, and gowns) intended to prevent skin and mucous membrane exposures. Other protective equipment (e.g., finger guards while suturing) might also reduce injuries during dental procedures (*104*).

Engineering controls are the primary method to reduce exposures to blood and OPIM from sharp instruments and needles. These controls are frequently technology-based and often incorporate safer designs of instruments and devices (e.g., self-sheathing anesthetic needles and dental units designed to shield burs in handpieces) to reduce percutaneous injuries (*101,103,108*).

Work-practice controls establish practices to protect DHCP whose responsibilities include handling, using, assembling, or processing sharp devices (e.g., needles, scalers, laboratory utility knives, burs, explorers, and endodontic files) or sharps disposal containers. Work-practice controls can include removing burs before disassembling the handpiece from the dental unit, restricting use of fingers in tissue retraction or palpation during suturing and administration of anesthesia, and minimizing potentially uncontrolled movements of such instruments as scalers or laboratory knives (*101,105*).

As indicated, needles are a substantial source of percutaneous injury in dental practice, and engineering and work-practice controls for needle handling are of particular importance. In 2001, revisions to OSHA's bloodborne pathogens standard as mandated by the Needlestick Safety and Prevention Act of 2000 became effective. These revisions clarify the need for employers to consider safer needle devices as they become available and to involve employees directly responsible for patient care (e.g., dentists, hygienists, and dental assistants) in identifying and choosing such devices (*109*). Safer versions of sharp devices used in hospital settings have become available (e.g., blunt suture needles, phlebotomy devices, and butterfly needles), and their impact on reducing injuries has been documented (*110–112*). Aspirating anesthetic syringes that incorporate safety features have been developed for dental procedures, but the low injury rates in dentistry limit assessment of their effect on reducing injuries among DHCP.

Work-practice controls for needles and other sharps include placing used disposable syringes and needles, scalpel blades, and other sharp items in appropriate puncture-resistant containers located as close as feasible to where the items were used (*2,7,13,113–115*). In addition, used needles should never be recapped or otherwise manipulated by using both hands, or any other technique that involves directing the point of a needle toward any part of the body (*2,7,13,97,113,114*). A one-handed scoop technique, a mechanical device designed for holding the needle cap to facilitate one-handed recapping, or an engineered sharps injury protection device (e.g., needles with resheathing mechanisms) should be employed for recapping needles between uses and before disposal (*2,7,13,113,114*). DHCP should never bend or break needles before disposal because this practice requires unnecessary manipulation. Before attempting to remove needles from nondisposable aspirating syringes, DHCP should recap them to prevent injuries. For procedures involving multiple injections with a single needle, the practitioner should recap the needle between injections by using a one-handed technique or use a device with a needle-resheathing mechanism. Passing a syringe with an unsheathed needle should be avoided because of the potential for injury.

Additional information for developing a safety program and for identifying and evaluating safer dental devices is available at

- http://www.cdc.gov/OralHealth/infectioncontrol/forms.htm (forms for screening and evaluating safer dental devices), and
- http://www.cdc.gov/niosh/topics/bbp (state legislation on needlestick safety).

Postexposure Management and Prophylaxis

Postexposure management is an integral component of a complete program to prevent infection after an occupational exposure to blood. During dental procedures, saliva is predictably contaminated with blood (*7,114*). Even when blood is not visible, it can still be present in limited quantities and therefore is considered a potentially infectious material by OSHA (*13,19*). A qualified health-care professional should evaluate any occupational exposure incident to blood or OPIM, including saliva, regardless of whether blood is visible, in dental settings (*13*).

Dental practices and laboratories should establish written, comprehensive programs that include hepatitis B vaccination and postexposure management protocols that 1) describe the types of contact with blood or OPIM that can place DHCP at risk for infection; 2) describe procedures for promptly reporting and evaluating such exposures; and 3) identify a health-

care professional who is qualified to provide counseling and perform all medical evaluations and procedures in accordance with current recommendations of the U.S. Public Health Service (PHS), including PEP with chemotherapeutic drugs when indicated. DHCP, including students, who might reasonably be considered at risk for occupational exposure to blood or OPIM should be taught strategies to prevent contact with blood or OPIM and the principles of postexposure management, including PEP options, as part of their job orientation and training. Educational programs for DHCP and students should emphasize reporting all exposures to blood or OPIM as soon as possible, because certain interventions have to be initiated promptly to be effective. Policies should be consistent with the practices and procedures for worker protection required by OSHA and with current PHS recommendations for managing occupational exposures to blood (*13,19*).

After an occupational blood exposure, first aid should be administered as necessary. Puncture wounds and other injuries to the skin should be washed with soap and water; mucous membranes should be flushed with water. No evidence exists that using antiseptics for wound care or expressing fluid by squeezing the wound further reduces the risk of bloodborne pathogen transmission; however, use of antiseptics is not contraindicated. The application of caustic agents (e.g., bleach) or the injection of antiseptics or disinfectants into the wound is not recommended (*19*). Exposed DHCP should immediately report the exposure to the infection-control coordinator or other designated person, who should initiate referral to the qualified health-care professional and complete necessary reports. Because multiple factors contribute to the risk of infection after an occupational exposure to blood, the following information should be included in the exposure report, recorded in the exposed person's confidential medical record, and provided to the qualified health-care professional:

- Date and time of exposure.
- Details of the procedure being performed, including where and how the exposure occurred and whether the exposure involved a sharp device, the type and brand of device, and how and when during its handling the exposure occurred.
- Details of the exposure, including its severity and the type and amount of fluid or material. For a percutaneous injury, severity might be measured by the depth of the wound, gauge of the needle, and whether fluid was injected; for a skin or mucous membrane exposure, the estimated volume of material, duration of contact, and the condition of the skin (e.g., chapped, abraded, or intact) should be noted.
- Details regarding whether the source material was known to contain HIV or other bloodborne pathogens, and, if the source was infected with HIV, the stage of disease, history of antiretroviral therapy, and viral load, if known.
- Details regarding the exposed person (e.g., hepatitis B vaccination and vaccine-response status).
- Details regarding counseling, postexposure management, and follow-up.

Each occupational exposure should be evaluated individually for its potential to transmit HBV, HCV, and HIV, based on the following:

- The type and amount of body substance involved.
- The type of exposure (e.g., percutaneous injury, mucous membrane or nonintact skin exposure, or bites resulting in blood exposure to either person involved).
- The infection status of the source.
- The susceptibility of the exposed person (*19*).

All of these factors should be considered in assessing the risk for infection and the need for further follow-up (e.g., PEP).

During 1990–1998, PHS published guidelines for PEP and other management of health-care worker exposures to HBV, HCV, or HIV (*69,116–119*). In 2001, these recommendations were updated and consolidated into one set of PHS guidelines (*19*). The new guidelines reflect the availability of new antiretroviral agents, new information regarding the use and safety of HIV PEP, and considerations regarding employing HIV PEP when resistance of the source patient's virus to antiretroviral agents is known or suspected. In addition, the 2001 guidelines provide guidance to clinicians and exposed HCP regarding when to consider HIV PEP and recommendations for PEP regimens (*19*).

Hand Hygiene

Hand hygiene (e.g., handwashing, hand antisepsis, or surgical hand antisepsis) substantially reduces potential pathogens on the hands and is considered the single most critical measure for reducing the risk of transmitting organisms to patients and HCP (*120–123*). Hospital-based studies have demonstrated that noncompliance with hand hygiene practices is associated with health-care–associated infections and the spread of multiresistant organisms. Noncompliance also has been a major contributor to outbreaks (*123*). The prevalence of health-care–associated infections decreases as adherence of HCP to recommended hand hygiene measures improves (*124–126*).

The microbial flora of the skin, first described in 1938, consist of transient and resident microorganisms (*127*). Transient flora, which colonize the superficial layers of the skin, are easier to remove by routine handwashing. They are often acquired by HCP during direct contact with patients or contaminated environmental surfaces; these organisms are most frequently

associated with health-care–associated infections. Resident flora attached to deeper layers of the skin are more resistant to removal and less likely to be associated with such infections.

The preferred method for hand hygiene depends on the type of procedure, the degree of contamination, and the desired persistence of antimicrobial action on the skin (Table 2). For routine dental examinations and nonsurgical procedures, handwashing and hand antisepsis is achieved by using either a plain or antimicrobial soap and water. If the hands are not visibly soiled, an alcohol-based hand rub is adequate.

The purpose of surgical hand antisepsis is to eliminate transient flora and reduce resident flora for the duration of a procedure to prevent introduction of organisms in the operative wound, if gloves become punctured or torn. Skin bacteria can rapidly multiply under surgical gloves if hands are washed with soap that is not antimicrobial (*127,128*). Thus, an antimicrobial soap or alcohol hand rub with persistent activity should be used before surgical procedures (*129–131*).

Agents used for surgical hand antisepsis should substantially reduce microorganisms on intact skin, contain a nonirritating antimicrobial preparation, have a broad spectrum of activity, be fast-acting, and have a persistent effect (*121,132–135*). Persistence (i.e., extended antimicrobial activity that prevents or inhibits survival of microorganisms after the product is applied) is critical because microorganisms can colonize on hands in the moist environment underneath gloves (*122*).

Alcohol hand rubs are rapidly germicidal when applied to the skin but should include such antiseptics as chlorhexidine, quaternary ammonium compounds, octenidine, or triclosan to achieve persistent activity (*130*). Factors that can influence the effectiveness of the surgical hand antisepsis in addition to the choice of antiseptic agent include duration and technique of scrubbing, as well as condition of the hands, and techniques used for drying and gloving. CDC's 2002 guideline on hand hygiene in health-care settings provides more complete information (*123*).

Selection of Antiseptic Agents

Selecting the most appropriate antiseptic agent for hand hygiene requires consideration of multiple factors. Essential performance characteristics of a product (e.g., the spectrum and persistence of activity and whether or not the agent is fast-acting) should be determined before selecting a product. Delivery system, cost per use, reliable vendor support and supply are also considerations. Because HCP acceptance is a major factor regarding compliance with recommended hand hygiene protocols (*122,123,147,148*), considering DHCP needs is critical and should include possible chemical allergies,

TABLE 2. Hand-hygiene methods and indications

Method	Agent	Purpose	Duration (minimum)	Indication*
Routine handwash	Water and nonantimicrobial soap (e.g., plain soap†)	Remove soil and transient microorganisms	15 seconds§	Before and after treating each patient (e.g., before glove placement and after glove removal). After barehanded touching of inanimate objects likely to be contaminated by blood or saliva. Before leaving the dental operatory or the dental laboratory. When visibly soiled.¶ Before regloving after removing gloves that are torn, cut, or punctured.
Antiseptic handwash	Water and antimicrobial soap (e.g., chlorhexidine, iodine and iodophors, chloroxylenol [PCMX], triclosan)	Remove or destroy transient microorganisms and reduce resident flora	15 seconds§	
Antiseptic hand rub	Alcohol-based hand rub¶	Remove or destroy transient microorganisms and reduce resident flora	Rub hands until the agent is dry¶	
Surgical antisepsis	Water and antimicrobial soap (e.g., chlorhexidine, iodine and iodophors, chloroxylenol [PCMX], triclosan) Water and non-antimicrobial soap (e.g., plain soap†) followed by an alcohol-based surgical hand-scrub product with persistent activity	Remove or destroy transient microorganisms and reduce resident flora (persistent effect)	2–6 minutes Follow manufacturer instructions for surgical hand-scrub product with persistent activity¶**	Before donning sterile surgeon's gloves for surgical procedures††

* (*7,9,11,13,113,120–123,125,126,136–138*).

† Pathogenic organisms have been found on or around bar soap during and after use (*139*). Use of liquid soap with hands-free dispensing controls is preferable.

§ Time reported as effective in removing most transient flora from the skin. For most procedures, a vigorous rubbing together of all surfaces of premoistened lathered hands and fingers for ≥15 seconds, followed by rinsing under a stream of cool or tepid water is recommended (*9,120,123,140,141*). Hands should always be dried thoroughly before donning gloves.

¶ Alcohol-based hand rubs should contain 60%–95% ethanol or isopropanol and should not be used in the presence of visible soil or organic material. If using an alcohol-based hand rub, apply adequate amount to palm of one hand and rub hands together, covering all surfaces of the hands and fingers, until hands are dry. Follow manufacturer's recommendations regarding the volume of product to use. If hands feel dry after rubbing them together for 10–15 seconds, an insufficient volume of product likely was applied. The drying effect of alcohol can be reduced or eliminated by adding 1%–3% glycerol or other skin-conditioning agents (*123*).

** After application of alcohol-based surgical hand-scrub product with persistent activity as recommended, allow hands and forearms to dry thoroughly and immediately don sterile surgeon's gloves (*144,145*). Follow manufacturer instructions (*122,123,137,146*).

†† Before beginning surgical hand scrub, remove all arm jewelry and any hand jewelry that may make donning gloves more difficult, cause gloves to tear more readily (*142,143*), or interfere with glove usage (e.g., ability to wear the correct-sized glove or altered glove integrity).

skin integrity after repeated use, compatibility with lotions used, and offensive agent ingredients (e.g., scent). Discussing specific preparations or ingredients used for hand antisepsis is beyond the scope of this report. DHCP should choose from commercially available HCP handwashes when selecting agents for hand antisepsis or surgical hand antisepsis.

Storage and Dispensing of Hand Care Products

Handwashing products, including plain (i.e., nonantimicrobial) soap and antiseptic products, can become contaminated or support the growth of microorganisms (*122*). Liquid products should be stored in closed containers and dispensed from either disposable containers or containers that are washed and dried thoroughly before refilling. Soap should not be added to a partially empty dispenser, because this practice of topping off might lead to bacterial contamination (*149,150*). Store and dispense products according to manufacturers' directions.

Lotions

The primary defense against infection and transmission of pathogens is healthy, unbroken skin. Frequent handwashing with soaps and antiseptic agents can cause chronic irritant contact dermatitis among DHCP. Damage to the skin changes skin flora, resulting in more frequent colonization by staphylococci and gram-negative bacteria (*151,152*). The potential of detergents to cause skin irritation varies considerably, but can be reduced by adding emollients. Lotions are often recommended to ease the dryness resulting from frequent handwashing and to prevent dermatitis from glove use (*153,154*). However, petroleum-based lotion formulations can weaken latex gloves and increase permeability. For that reason, lotions that contain petroleum or other oil emollients should only be used at the end of the work day (*122,155*). Dental practitioners should obtain information from lotion manufacturers regarding interaction between lotions, gloves, dental materials, and antimicrobial products.

Fingernails and Artificial Nails

Although the relationship between fingernail length and wound infection is unknown, keeping nails short is considered key because the majority of flora on the hands are found under and around the fingernails (*156*). Fingernails should be short enough to allow DHCP to thoroughly clean underneath them and prevent glove tears (*122*). Sharp nail edges or broken nails are also likely to increase glove failure. Long artificial or natural nails can make donning gloves more difficult and can cause gloves to tear more readily. Hand carriage of gram-negative organisms has been determined to be greater among wearers of artificial nails than among nonwearers, both before and after handwashing (*157–160*). In addition, artificial fingernails or extenders have been epidemiologically implicated in multiple outbreaks involving fungal and bacterial infections in hospital intensive-care units and operating rooms (*161–164*). Freshly applied nail polish on natural nails does not increase the microbial load from periungual skin if fingernails are short; however, chipped nail polish can harbor added bacteria (*165,166*).

Jewelry

Studies have demonstrated that skin underneath rings is more heavily colonized than comparable areas of skin on fingers without rings (*167–170*). In a study of intensive-care nurses, multivariable analysis determined rings were the only substantial risk factor for carriage of gram-negative bacilli and *Staphylococcus aureus,* and the concentration of organisms correlated with the number of rings worn (*170*). However, two other studies demonstrated that mean bacterial colony counts on hands after handwashing were similar among persons wearing rings and those not wearing rings (*169,171*). Whether wearing rings increases the likelihood of transmitting a pathogen is unknown; further studies are needed to establish whether rings result in higher transmission of pathogens in health-care settings. However, rings and decorative nail jewelry can make donning gloves more difficult and cause gloves to tear more readily (*142,143*). Thus, jewelry should not interfere with glove use (e.g., impair ability to wear the correct-sized glove or alter glove integrity).

Personal Protective Equipment

PPE is designed to protect the skin and the mucous membranes of the eyes, nose, and mouth of DHCP from exposure to blood or OPIM. Use of rotary dental and surgical instruments (e.g., handpieces or ultrasonic scalers) and air-water syringes creates a visible spray that contains primarily large-particle droplets of water, saliva, blood, microorganisms, and other debris. This spatter travels only a short distance and settles out quickly, landing on the floor, nearby operatory surfaces, DHCP, or the patient. The spray also might contain certain aerosols (i.e., particles of respirable size, <10 μm). Aerosols can remain airborne for extended periods and can be inhaled. However, they should not be confused with the large-particle spatter that makes up the bulk of the spray from handpieces and ultrasonic scalers. Appropriate work practices, including use of dental dams (*172*) and high-velocity air evacuation, should minimize dissemination of droplets, spatter, and aerosols (*2*).

Primary PPE used in oral health-care settings includes gloves, surgical masks, protective eyewear, face shields, and protective

clothing (e.g., gowns and jackets). All PPE should be removed before DHCP leave patient-care areas (*13*). Reusable PPE (e.g., clinician or patient protective eyewear and face shields) should be cleaned with soap and water, and when visibly soiled, disinfected between patients, according to the manufacturer's directions (*2,13*). Wearing gloves, surgical masks, protective eyewear, and protective clothing in specified circumstances to reduce the risk of exposures to bloodborne pathogens is mandated by OSHA (*13*). General work clothes (e.g., uniforms, scrubs, pants, and shirts) are neither intended to protect against a hazard nor considered PPE.

Masks, Protective Eyewear, Face Shields

A surgical mask that covers both the nose and mouth and protective eyewear with solid side shields or a face shield should be worn by DHCP during procedures and patient-care activities likely to generate splashes or sprays of blood or body fluids. Protective eyewear for patients shields their eyes from spatter or debris generated during dental procedures. A surgical mask protects against microorganisms generated by the wearer, with >95% bacterial filtration efficiency, and also protects DHCP from large-particle droplet spatter that might contain bloodborne pathogens or other infectious microorganisms (*173*). The mask's outer surface can become contaminated with infectious droplets from spray of oral fluids or from touching the mask with contaminated fingers. Also, when a mask becomes wet from exhaled moist air, the resistance to airflow through the mask increases, causing more airflow to pass around edges of the mask. If the mask becomes wet, it should be changed between patients or even during patient treatment, when possible (*2,174*).

When airborne infection isolation precautions (expanded or transmission-based) are necessary (e.g., for TB patients), a National Institute for Occupational Safety and Health (NIOSH)-certified particulate-filter respirator (e.g., N95, N99, or N100) should be used (*20*). *N95* refers to the ability to filter 1-µm particles in the unloaded state with a filter efficiency of >95% (i.e., filter leakage <5%), given flow rates of ≤50 L/min (i.e., approximate maximum airflow rate of HCP during breathing). Available data indicate infectious droplet nuclei measure 1–5 µm; therefore, respirators used in healthcare settings should be able to efficiently filter the smallest particles in this range.

The majority of surgical masks are not NIOSH-certified as respirators, do not protect the user adequately from exposure to TB, and do not satisfy OSHA requirements for respiratory protection (*174,175*). However, certain surgical masks (i.e., surgical N95 respirator) do meet the requirements and are certified by NIOSH as respirators. The level of protection a respirator provides is determined by the efficiency of the filter material for incoming air and how well the face piece fits or seals to the face (e.g., qualitatively or quantitatively tested in a reliable way to obtain a face-seal leakage of <10% and to fit the different facial sizes and characteristics of HCP).

When respirators are used while treating patients with diseases requiring airborne-transmission precautions (e.g., TB), they should be used in the context of a complete respiratory protection program (*175*). This program should include training and fit testing to ensure an adequate seal between the edges of the respirator and the wearer's face. Detailed information regarding respirator programs, including fit-test procedures are available at http://www.cdc.gov/niosh/99-143.html (*174,176*).

Protective Clothing

Protective clothing and equipment (e.g., gowns, lab coats, gloves, masks, and protective eyewear or face shield) should be worn to prevent contamination of street clothing and to protect the skin of DHCP from exposures to blood and body substances (*2,7,10,11,13,137*). OSHA bloodborne pathogens standard requires sleeves to be long enough to protect the forearms when the gown is worn as PPE (i.e., when spatter and spray of blood, saliva, or OPIM to the forearms is anticipated) (*13,14*). DHCP should change protective clothing when it becomes visibly soiled and as soon as feasible if penetrated by blood or other potentially infectious fluids (*2,13,14,137*). All protective clothing should be removed before leaving the work area (*13*).

Gloves and Gloving

DHCP wear gloves to prevent contamination of their hands when touching mucous membranes, blood, saliva, or OPIM, and also to reduce the likelihood that microorganisms present on the hands of DHCP will be transmitted to patients during surgical or other patient-care procedures (*1,2,7,10*). Medical gloves, both patient examination and surgeon's gloves, are manufactured as single-use disposable items that should be used for only one patient, then discarded. Gloves should be changed between patients and when torn or punctured.

Wearing gloves does not eliminate the need for handwashing. Hand hygiene should be performed immediately before donning gloves. Gloves can have small, unapparent defects or can be torn during use, and hands can become contaminated during glove removal (*122,177–187*). These circumstances increase the risk of operative wound contamination and exposure of the DHCP's hands to microorganisms from patients. In addition, bacteria can multiply rapidly in the moist environments underneath gloves, and thus, the hands should be dried thoroughly before donning gloves and washed again immediately after glove removal.

Types of Gloves

Because gloves are task-specific, their selection should be based on the type of procedure to be performed (e.g., surgery or patient examination) (Table 3). Sterile surgeon's gloves must meet standards for sterility assurance established by FDA and are less likely than patient examination gloves to harbor pathogens that could contaminate an operative wound (*188*). Appropriate gloves in the correct size should be readily accessible (*13*).

Glove Integrity

Limited studies of the penetrability of different glove materials under conditions of use have been conducted in the dental environment. Consistent with observations in clinical medicine, leakage rates vary by glove material (e.g., latex, vinyl, and nitrile), duration of use, and type of procedure performed (*182,184,186,189–191*), as well as by manufacturer (*192–194*). The frequency of perforations in surgeon's gloves used during outpatient oral surgical procedures has been determined to range from 6% to 16% (*181,185,195,196*).

Studies have demonstrated that HCP and DHCP are frequently unaware of minute tears in gloves that occur during use (*186,190,191,197*). These studies determined that gloves developed defects in 30 minutes–3 hours, depending on type of glove and procedure. Investigators did not determine an optimal time for changing gloves during procedures.

During dental procedures, patient examination and surgeon's gloves commonly contact multiple types of chemicals and materials (e.g., disinfectants and antiseptics, composite resins, and bonding agents) that can compromise the integrity of latex as well as vinyl, nitrile, and other synthetic glove materials (*198–206*). In addition, latex gloves can interfere with the setting of vinyl polysiloxane impression materials (*207–209*), although the setting is apparently not adversely affected by synthetic vinyl gloves (*207,208*). Given the diverse selection of dental materials on the market, dental practitioners should consult glove manufacturers regarding the chemical compatibility of glove materials.

If the integrity of a glove is compromised (e.g., punctured), it should be changed as soon as possible (*13,210,211*). Washing latex gloves with plain soap, chlorhexidine, or alcohol can lead to the formation of glove micropunctures (*177,212,213*) and subsequent hand contamination (*138*). Because this condition, known as wicking, can allow penetration of liquids through undetected holes, washing gloves is not recommended. After a hand rub with alcohol, the hands should be thoroughly

TABLE 3. Glove types and indications

Glove	Indication	Comment	Commercially available glove materials*	
			Material	Attributes†
Patient examination gloves§	Patient care, examinations, other nonsurgical procedures involving contact with mucous membranes, and laboratory procedures	Medical device regulated by the Food and Drug Administration (FDA).	Natural-rubber latex (NRL)	1, 2
			Nitrile	2, 3
			Nitrile and chloroprene (neoprene) blends	2, 3
		Nonsterile and sterile single-use disposable. Use for one patient and discard appropriately.	Nitrile & NRL blends	1, 2, 3
			Butadiene methyl methacrylate	2, 3
			Polyvinyl chloride (PVC, vinyl)	4
			Polyurethane	4
			Styrene-based copolymer	4, 5
Surgeon's gloves§	Surgical procedures	Medical device regulated by the FDA.	NRL	1, 2
			Nitrile	2, 3
		Sterile and single-use disposable. Use for one patient and discard appropriately.	Chloroprene (neoprene)	2, 3
			NRL and nitrile or chloroprene blends	2, 3
			Synthetic polyisoprene	2
			Styrene-based copolymer	4, 5
			Polyurethane	4
Nonmedical gloves	Housekeeping procedures (e.g., cleaning and disinfection)	Not a medical device regulated by the FDA.	NRL and nitrile or chloroprene blends	2, 3
			Chloroprene (neoprene)	2, 3
		Commonly referred to as utility, industrial, or general purpose gloves. Should be puncture- or chemical-resistant, depending on the task. Latex gloves do not provide adequate chemical protection.	Nitrile	2, 3
			Butyl rubber	2, 3
	Handling contaminated sharps or chemicals		Fluoroelastomer	3, 4, 6
			Polyethylene and ethylene vinyl alcohol copolymer	3, 4, 6
	Not for use during patient care	Sanitize after use.		

* Physical properties can vary by material, manufacturer, and protein and chemical composition.
† 1 contains allergenic NRL proteins.
2 vulcanized rubber, contains allergenic rubber processing chemicals.
3 likely to have enhanced chemical or puncture resistance.
4 nonvulcanized and does not contain rubber processing chemicals.
5 inappropriate for use with methacrylates.
6 resistant to most methacrylates.
§ Medical or dental gloves include patient-examination gloves and surgeon's (i.e., surgical) gloves and are medical devices regulated by the FDA. Only FDA-cleared medical or dental patient-examination gloves and surgical gloves can be used for patient care.

dried before gloving, because hands still wet with an alcohol-based hand hygiene product can increase the risk of glove perforation (*192*).

FDA regulates the medical glove industry, which includes gloves marketed as sterile surgeon's and sterile or nonsterile patient examination gloves. General-purpose utility gloves are also used in dental health-care settings but are not regulated by FDA because they are not promoted for medical use. More rigorous standards are applied to surgeon's than to examination gloves. FDA has identified acceptable quality levels (e.g., maximum defects allowed) for glove manufacturers (*214*), but even intact gloves eventually fail with exposure to mechanical (e.g., sharps, fingernails, or jewelry) and chemical (e.g., dimethyacrylates) hazards and over time. These variables can be controlled, ultimately optimizing glove performance, by 1) maintaining short fingernails, 2) minimizing or eliminating hand jewelry, and 3) using engineering and work-practice controls to avoid injuries with sharps.

Sterile Surgeon's Gloves and Double-Gloving During Oral Surgical Procedures

Certain limited studies have determined no difference in postoperative infection rates after routine tooth extractions when surgeons wore either sterile or nonsterile gloves (*215,216*). However, wearing sterile surgeon's gloves during surgical procedures is supported by a strong theoretical rationale (*2,7,137*). Sterile gloves minimize transmission of microorganisms from the hands of surgical DHCP to patients and prevent contamination of the hands of surgical DHCP with the patient's blood and body fluids (*137*). In addition, sterile surgeon's gloves are more rigorously regulated by FDA and therefore might provide an increased level of protection for the provider if exposure to blood is likely.

Although the effectiveness of wearing two pairs of gloves in preventing disease transmission has not been demonstrated, the majority of studies among HCP and DHCP have demonstrated a lower frequency of inner glove perforation and visible blood on the surgeon's hands when double gloves are worn (*181,185,195,196,198,217–219*). In one study evaluating double gloves during oral surgical and dental hygiene procedures, the perforation of outer latex gloves was greater during longer procedures (i.e., >45 minutes), with the highest rate (10%) of perforation occurring during oral surgery procedures (*196*). Based on these studies, double gloving might provide additional protection from occupational blood contact (*220*). Double gloving does not appear to substantially reduce either manual dexterity or tactile sensitivity (*221–223*). Additional protection might also be provided by specialty products (e.g., orthopedic surgical gloves and glove liners) (*224*).

Contact Dermatitis and Latex Hypersensitivity

Occupationally related contact dermatitis can develop from frequent and repeated use of hand hygiene products, exposure to chemicals, and glove use. Contact dermatitis is classified as either irritant or allergic. Irritant contact dermatitis is common, nonallergic, and develops as dry, itchy, irritated areas on the skin around the area of contact. By comparison, allergic contact dermatitis (type IV hypersensitivity) can result from exposure to accelerators and other chemicals used in the manufacture of rubber gloves (e.g., natural rubber latex, nitrile, and neoprene), as well as from other chemicals found in the dental practice setting (e.g., methacrylates and glutaraldehyde). Allergic contact dermatitis often manifests as a rash beginning hours after contact and, similar to irritant dermatitis, is usually confined to the area of contact.

Latex allergy (type I hypersensitivity to latex proteins) can be a more serious systemic allergic reaction, usually beginning within minutes of exposure but sometimes occurring hours later and producing varied symptoms. More common reactions include runny nose, sneezing, itchy eyes, scratchy throat, hives, and itchy burning skin sensations. More severe symptoms include asthma marked by difficult breathing, coughing spells, and wheezing; cardiovascular and gastrointestinal ailments; and in rare cases, anaphylaxis and death (*32,225*). The American Dental Association (ADA) began investigating the prevalence of type I latex hypersensitivity among DHCP at the ADA annual meeting in 1994. In 1994 and 1995, approximately 2,000 dentists, hygienists, and assistants volunteered for skin-prick testing. Data demonstrated that 6.2% of those tested were positive for type I latex hypersensitivity (*226*). Data from the subsequent 5 years of this ongoing cross-sectional study indicated a decline in prevalence from 8.5% to 4.3% (*227*). This downward trend is similar to that reported by other studies and might be related to use of latex gloves with lower allergen content (*228–230*).

Natural rubber latex proteins responsible for latex allergy are attached to glove powder. When powdered latex gloves are worn, more latex protein reaches the skin. In addition, when powdered latex gloves are donned or removed, latex protein/powder particles become aerosolized and can be inhaled, contacting mucous membranes (*231*). As a result, allergic patients and DHCP can experience cutaneous, respiratory, and conjunctival symptoms related to latex protein exposure. DHCP can become sensitized to latex protein with repeated exposure (*232–236*). Work areas where only powder-free, low-allergen latex gloves are used demonstrate low or undetectable amounts of latex allergy-causing proteins (*237–239*) and fewer symptoms among HCP related to natural rubber latex allergy.

Because of the role of glove powder in exposure to latex protein, NIOSH recommends that if latex gloves are chosen, HCP should be provided with reduced protein, powder-free gloves (*32*). Nonlatex (e.g., nitrile or vinyl) powder-free and low-protein gloves are also available (*31,240*). Although rare, potentially life-threatening anaphylactic reactions to latex can occur; dental practices should be appropriately equipped and have procedures in place to respond to such emergencies.

DHCP and dental patients with latex allergy should not have direct contact with latex-containing materials and should be in a latex-safe environment with all latex-containing products removed from their vicinity (*31*). Dental patients with histories of latex allergy can be at risk from dental products (e.g., prophylaxis cups, rubber dams, orthodontic elastics, and medication vials) (*241*). Any latex-containing devices that cannot be removed from the treatment environment should be adequately covered or isolated. Persons might also be allergic to chemicals used in the manufacture of natural rubber latex and synthetic rubber gloves as well as metals, plastics, or other materials used in dental care. Taking thorough health histories for both patients and DHCP, followed by avoidance of contact with potential allergens can minimize the possibility of adverse reactions. Certain common predisposing conditions for latex allergy include previous history of allergies, a history of spina bifida, urogenital anomalies, or allergies to avocados, kiwis, nuts, or bananas. The following precautions should be considered to ensure safe treatment for patients who have possible or documented latex allergy:

- Be aware that latent allergens in the ambient air can cause respiratory or anaphylactic symptoms among persons with latex hypersensitivity. Patients with latex allergy can be scheduled for the first appointment of the day to minimize their inadvertent exposure to airborne latex particles.
- Communicate with other DHCP regarding patients with latex allergy (e.g., by oral instructions, written protocols, and posted signage) to prevent them from bringing latex-containing materials into the treatment area.
- Frequently clean all working areas contaminated with latex powder or dust.
- Have emergency treatment kits with latex-free products available at all times.
- If latex-related complications occur during or after a procedure, manage the reaction and seek emergency assistance as indicated. Follow current medical emergency response recommendations for management of anaphylaxis (*32*).

Sterilization and Disinfection of Patient-Care Items

Patient-care items (dental instruments, devices, and equipment) are categorized as critical, semicritical, or noncritical, depending on the potential risk for infection associated with their intended use (Table 4) (*242*). Critical items used to penetrate soft tissue or bone have the greatest risk of transmitting infection and should be sterilized by heat. Semicritical items touch mucous membranes or nonintact skin and have a lower risk of transmission; because the majority of semicritical items in dentistry are heat-tolerant, they also should be sterilized by using heat. If a semicritical item is heat-sensitive, it should, at a minimum, be processed with high-level disinfection (*2*).

Noncritical patient-care items pose the least risk of transmission of infection, contacting only intact skin, which can serve as an effective barrier to microorganisms. In the majority of cases, cleaning, or if visibly soiled, cleaning followed by disinfection with an EPA-registered hospital disinfectant is adequate. When the item is visibly contaminated with blood or OPIM, an EPA-registered hospital disinfectant with a tuberculocidal claim (i.e., intermediate-level disinfectant) should be used (*2,243,244*). Cleaning or disinfection of certain noncritical patient-care items can be difficult or damage the surfaces; therefore, use of disposable barrier protection of these surfaces might be a preferred alternative.

FDA-cleared sterilant/high-level disinfectants and EPA-registered disinfectants must have clear label claims for intended use, and manufacturer instructions for use must be followed (*245*). A more complete description of the regulatory framework in the United States by which liquid chemical germicides are evaluated and regulated is included (Appendix A).

TABLE 4. Infection-control categories of patient-care instruments

Category	Definition	Dental instrument or item
Critical	Penetrates soft tissue, contacts bone, enters into or contacts the bloodstream or other normally sterile tissue.	Surgical instruments, periodontal scalers, scalpel blades, surgical dental burs
Semicritical	Contacts mucous membranes or nonintact skin; will not penetrate soft tissue, contact bone, enter into or contact the bloodstream or other normally sterile tissue.	Dental mouth mirror, amalgam condenser, reusable dental impression trays, dental handpieces*
Noncritical	Contacts intact skin.	Radiograph head/cone, blood pressure cuff, facebow, pulse oximeter

* Although dental handpieces are considered a semicritical item, they should always be heat-sterilized between uses and not high-level disinfected (*246*). See Dental Handpieces and Other Devices Attached to Air or Waterlines for detailed information.

Three levels of disinfection, high, intermediate, and low, are used for patient-care devices that do not require sterility and two levels, intermediate and low, for environmental surfaces (*242*). The intended use of the patient-care item should determine the recommended level of disinfection. Dental practices should follow the product manufacturer's directions regarding concentrations and exposure time for disinfectant activity relative to the surface to be disinfected (*245*). A summary of sterilization and disinfection methods is included (Appendix C).

Transporting and Processing Contaminated Critical and Semicritical Patient-Care Items

DHCP can be exposed to microorganisms on contaminated instruments and devices through percutaneous injury, contact with nonintact skin on the hands, or contact with mucous membranes of the eyes, nose, or mouth. Contaminated instruments should be handled carefully to prevent exposure to sharp instruments that can cause a percutaneous injury. Instruments should be placed in an appropriate container at the point of use to prevent percutaneous injuries during transport to the instrument processing area (*13*).

Instrument processing requires multiple steps to achieve sterilization or high-level disinfection. Sterilization is a complex process requiring specialized equipment, adequate space, qualified DHCP who are provided with ongoing training, and regular monitoring for quality assurance (*247*). Correct cleaning, packaging, sterilizer loading procedures, sterilization methods, or high-level disinfection methods should be followed to ensure that an instrument is adequately processed and safe for reuse on patients.

Instrument Processing Area

DHCP should process all instruments in a designated central processing area to more easily control quality and ensure safety (*248*). The central processing area should be divided into sections for 1) receiving, cleaning, and decontamination; 2) preparation and packaging; 3) sterilization; and 4) storage. Ideally, walls or partitions should separate the sections to control traffic flow and contain contaminants generated during processing. When physical separation of these sections cannot be achieved, adequate spatial separation might be satisfactory if the DHCP who process instruments are trained in work practices to prevent contamination of clean areas (*248*). Space should be adequate for the volume of work anticipated and the items to be stored (*248*).

Receiving, Cleaning, and Decontamination

Reusable instruments, supplies, and equipment should be received, sorted, cleaned, and decontaminated in one section of the processing area. Cleaning should precede all disinfection and sterilization processes; it should involve removal of debris as well as organic and inorganic contamination. Removal of debris and contamination is achieved either by scrubbing with a surfactant, detergent, and water, or by an automated process (e.g., ultrasonic cleaner or washer-disinfector) using chemical agents. If visible debris, whether inorganic or organic matter, is not removed, it will interfere with microbial inactivation and can compromise the disinfection or sterilization process (*244,249–252*). After cleaning, instruments should be rinsed with water to remove chemical or detergent residue. Splashing should be minimized during cleaning and rinsing (*13*). Before final disinfection or sterilization, instruments should be handled as though contaminated.

Considerations in selecting cleaning methods and equipment include 1) efficacy of the method, process, and equipment; 2) compatibility with items to be cleaned; and 3) occupational health and exposure risks. Use of automated cleaning equipment (e.g., ultrasonic cleaner or washer-disinfector) does not require presoaking or scrubbing of instruments and can increase productivity, improve cleaning effectiveness, and decrease worker exposure to blood and body fluids. Thus, using automated equipment can be safer and more efficient than manually cleaning contaminated instruments (*253*).

If manual cleaning is not performed immediately, placing instruments in a puncture-resistant container and soaking them with detergent, a disinfectant/detergent, or an enzymatic cleaner will prevent drying of patient material and make cleaning easier and less time-consuming. Use of a liquid chemical sterilant/high-level disinfectant (e.g., glutaraldehyde) as a holding solution is not recommended (*244*). Using work-practice controls (e.g., long-handled brush) to keep the scrubbing hand away from sharp instruments is recommended (*14*). To avoid injury from sharp instruments, DHCP should wear puncture-resistant, heavy-duty utility gloves when handling or manually cleaning contaminated instruments and devices (*6*). Employees should not reach into trays or containers holding sharp instruments that cannot be seen (e.g., sinks filled with soapy water in which sharp instruments have been placed). Work-practice controls should include use of a strainer-type basket to hold instruments and forceps to remove the items. Because splashing is likely to occur, a mask, protective eyewear or face shield, and gown or jacket should be worn (*13*).

Preparation and Packaging

In another section of the processing area, cleaned instruments and other dental supplies should be inspected, assembled into sets or trays, and wrapped, packaged, or placed into container systems for sterilization. Hinged instruments should be processed open and unlocked. An internal chemical indicator should be placed in every package. In addition, an external

chemical indicator (e.g., chemical indicator tape) should be used when the internal indicator cannot be seen from outside the package. For unwrapped loads, at a minimum, an internal chemical indicator should be placed in the tray or cassette with items to be sterilized (*254*) (see Sterilization of Unwrapped Instruments). Dental practices should refer to the manufacturer's instructions regarding use and correct placement of chemical indicators (see Sterilization Monitoring). Critical and semicritical instruments that will be stored should be wrapped or placed in containers (e.g., cassettes or organizing trays) designed to maintain sterility during storage (*2,247,255–257*).

Packaging materials (e.g., wraps or container systems) allow penetration of the sterilization agent and maintain sterility of the processed item after sterilization. Materials for maintaining sterility of instruments during transport and storage include wrapped perforated instrument cassettes, peel pouches of plastic or paper, and sterilization wraps (i.e., woven and nonwoven). Packaging materials should be designed for the type of sterilization process being used (*256–259*).

Sterilization

The sterilization section of the processing area should include the sterilizers and related supplies, with adequate space for loading, unloading, and cool down. The area can also include incubators for analyzing spore tests and enclosed storage for sterile items and disposable (single-use) items (*260*). Manufacturer and local building code specifications will determine placement and room ventilation requirements.

Sterilization Procedures. Heat-tolerant dental instruments usually are sterilized by 1) steam under pressure (autoclaving), 2) dry heat, or 3) unsaturated chemical vapor. All sterilization should be performed by using medical sterilization equipment cleared by FDA. The sterilization times, temperatures, and other operating parameters recommended by the manufacturer of the equipment used, as well as instructions for correct use of containers, wraps, and chemical or biological indicators, should always be followed (*243,247*).

Items to be sterilized should be arranged to permit free circulation of the sterilizing agent (e.g., steam, chemical vapor, or dry heat); manufacturer's instructions for loading the sterilizer should be followed (*248,260*). Instrument packs should be allowed to dry inside the sterilizer chamber before removing and handling. Packs should not be touched until they are cool and dry because hot packs act as wicks, absorbing moisture, and hence, bacteria from hands (*247*). The ability of equipment to attain physical parameters required to achieve sterilization should be monitored by mechanical, chemical, and biological indicators. Sterilizers vary in their types of indicators and their ability to provide readings on the mechanical or physical parameters of the sterilization process (e.g., time, temperature, and pressure). Consult with the sterilizer manufacturer regarding selection and use of indicators.

Steam Sterilization. Among sterilization methods, steam sterilization, which is dependable and economical, is the most widely used for wrapped and unwrapped critical and semicritical items that are not sensitive to heat and moisture (*260*). Steam sterilization requires exposure of each item to direct steam contact at a required temperature and pressure for a specified time needed to kill microorganisms. Two basic types of steam sterilizers are the gravity displacement and the high-speed prevacuum sterilizer.

The majority of tabletop sterilizers used in a dental practice are gravity displacement sterilizers, although prevacuum sterilizers are becoming more widely available. In gravity displacement sterilizers, steam is admitted through steam lines, a steam generator, or self-generation of steam within the chamber. Unsaturated air is forced out of the chamber through a vent in the chamber wall. Trapping of air is a concern when using saturated steam under gravity displacement; errors in packaging items or overloading the sterilizer chamber can result in cool air pockets and items not being sterilized.

Prevacuum sterilizers are fitted with a pump to create a vacuum in the chamber and ensure air removal from the sterilizing chamber before the chamber is pressurized with steam. Relative to gravity displacement, this procedure allows faster and more positive steam penetration throughout the entire load. Prevacuum sterilizers should be tested periodically for adequate air removal, as recommended by the manufacturer. Air not removed from the chamber will interfere with steam contact. If a sterilizer fails the air removal test, it should not be used until inspected by sterilizer maintenance personnel and it passes the test (*243,247*). Manufacturer's instructions, with specific details regarding operation and user maintenance information, should be followed.

Unsaturated Chemical-Vapor Sterilization. Unsaturated chemical-vapor sterilization involves heating a chemical solution of primarily alcohol with 0.23% formaldehyde in a closed pressurized chamber. Unsaturated chemical vapor sterilization of carbon steel instruments (e.g., dental burs) causes less corrosion than steam sterilization because of the low level of water present during the cycle. Instruments should be dry before sterilizing. State and local authorities should be consulted for hazardous waste disposal requirements for the sterilizing solution.

Dry-Heat Sterilization. Dry heat is used to sterilize materials that might be damaged by moist heat (e.g., burs and certain orthodontic instruments). Although dry heat has the advantages of low operating cost and being noncorrosive, it is

a prolonged process and the high temperatures required are not suitable for certain patient-care items and devices (*261*).

Dry-heat sterilizers used in dentistry include static-air and forced-air types.

- The static-air type is commonly called an oven-type sterilizer. Heating coils in the bottom or sides of the unit cause hot air to rise inside the chamber through natural convection.
- The forced-air type is also known as a rapid heat-transfer sterilizer. Heated air is circulated throughout the chamber at a high velocity, permitting more rapid transfer of energy from the air to the instruments, thereby reducing the time needed for sterilization.

Sterilization of Unwrapped Instruments. An unwrapped cycle (sometimes called *flash sterilization*) is a method for sterilizing unwrapped patient-care items for immediate use. The time required for unwrapped sterilization cycles depends on the type of sterilizer and the type of item (i.e., porous or nonporous) to be sterilized (*243*). The unwrapped cycle in tabletop sterilizers is preprogrammed by the manufacturer to a specific time and temperature setting and can include a drying phase at the end to produce a dry instrument with much of the heat dissipated. If the drying phase requirements are unclear, the operation manual or manufacturer of the sterilizer should be consulted. If the unwrapped sterilization cycle in a steam sterilizer does not include a drying phase, or has only a minimal drying phase, items retrieved from the sterilizer will be hot and wet, making aseptic transport to the point of use more difficult. For dry-heat and chemical-vapor sterilizers, a drying phase is not required.

Unwrapped sterilization should be used only under certain conditions: 1) thorough cleaning and drying of instruments precedes the unwrapped sterilization cycle; 2) mechanical monitors are checked and chemical indicators used for each cycle; 3) care is taken to avoid thermal injury to DHCP or patients; and 4) items are transported aseptically to the point of use to maintain sterility (*134,258,262*). Because all implantable devices should be quarantined after sterilization until the results of biological monitoring are known, unwrapped or flash sterilization of implantable items is not recommended (*134*).

Critical instruments sterilized unwrapped should be transferred immediately by using aseptic technique, from the sterilizer to the actual point of use. Critical instruments should not be stored unwrapped (*260*). Semicritical instruments that are sterilized unwrapped on a tray or in a container system should be used immediately or within a short time. When sterile items are open to the air, they will eventually become contaminated. Storage, even temporary, of unwrapped semicritical instruments is discouraged because it permits exposure to dust, airborne organisms, and other unnecessary contamination before use on a patient (*260*). A carefully written protocol for minimizing the risk of contaminating unwrapped instruments should be prepared and followed (*260*).

Other Sterilization Methods. Heat-sensitive critical and semicritical instruments and devices can be sterilized by immersing them in liquid chemical germicides registered by FDA as sterilants. When using a liquid chemical germicide for sterilization, certain poststerilization procedures are essential. Items need to be 1) rinsed with sterile water after removal to remove toxic or irritating residues; 2) handled using sterile gloves and dried with sterile towels; and 3) delivered to the point of use in an aseptic manner. If stored before use, the instrument should not be considered sterile and should be sterilized again just before use. In addition, the sterilization process with liquid chemical sterilants cannot be verified with biological indicators (*263*).

Because of these limitations and because liquid chemical sterilants can require approximately 12 hours of complete immersion, they are almost never used to sterilize instruments. Rather, these chemicals are more often used for high-level disinfection (*249*). Shorter immersion times (12–90 minutes) are used to achieve high-level disinfection of semicritical instruments or items. These powerful, sporicidal chemicals (e.g., glutaraldehyde, peracetic acid, and hydrogen peroxide) are highly toxic (*244,264,265*). Manufacturer instructions (e.g., regarding dilution, immersion time, and temperature) and safety precautions for using chemical sterilants/high-level disinfectants must be followed precisely (*15,245*). These chemicals should not be used for applications other than those indicated in their label instructions. Misapplications include use as an environmental surface disinfectant or instrument-holding solution.

When using appropriate precautions (e.g., closed containers to limit vapor release, chemically resistant gloves and aprons, goggles, and face shields), glutaraldehyde-based products can be used without tissue irritation or adverse health effects. However, dermatologic, eye irritation, respiratory effects, and skin sensitization have been reported (*266–268*). Because of their lack of chemical resistance to glutaraldehydes, medical gloves are not an effective barrier (*200,269,270*). Other factors might apply (e.g., room exhaust ventilation or 10 air exchanges/hour) to ensure DHCP safety (*266,271*). For all of these reasons, using heat-sensitive semicritical items that must be processed with liquid chemical germicides is discouraged; heat-tolerant or disposable alternatives are available for the majority of such items.

Low-temperature sterilization with ethylene oxide gas (ETO) has been used extensively in larger health-care facilities. Its primary advantage is the ability to sterilize heat- and moisture-sensitive patient-care items with reduced deleterious effects. However, extended sterilization times of 10–48 hours

and potential hazards to patients and DHCP requiring stringent health and safety requirements (*272–274*) make this method impractical for private-practice settings. Handpieces cannot be effectively sterilized with this method because of decreased penetration of ETO gas flow through a small lumen (*250,275*). Other types of low-temperature sterilization (e.g., hydrogen peroxide gas plasma) exist but are not yet practical for dental offices.

Bead sterilizers have been used in dentistry to sterilize small metallic instruments (e.g., endodontic files). FDA has determined that a risk of infection exists with these devices because of their potential failure to sterilize dental instruments and has required their commercial distribution cease unless the manufacturer files a premarket approval application. If a bead sterilizer is employed, DHCP assume the risk of employing a dental device FDA has deemed neither safe nor effective (*276*).

Sterilization Monitoring. Monitoring of sterilization procedures should include a combination of process parameters, including mechanical, chemical, and biological (*247,248,277*). These parameters evaluate both the sterilizing conditions and the procedure's effectiveness.

Mechanical techniques for monitoring sterilization include assessing cycle time, temperature, and pressure by observing the gauges or displays on the sterilizer and noting these parameters for each load (*243,248*). Some tabletop sterilizers have recording devices that print out these parameters. Correct readings do not ensure sterilization, but incorrect readings can be the first indication of a problem with the sterilization cycle.

Chemical indicators, internal and external, use sensitive chemicals to assess physical conditions (e.g., time and temperature) during the sterilization process. Although chemical indicators do not prove sterilization has been achieved, they allow detection of certain equipment malfunctions, and they can help identify procedural errors. External indicators applied to the outside of a package (e.g., chemical indicator tape or special markings) change color rapidly when a specific parameter is reached, and they verify that the package has been exposed to the sterilization process. Internal chemical indicators should be used inside each package to ensure the sterilizing agent has penetrated the packaging material and actually reached the instruments inside. A single-parameter internal chemical indicator provides information regarding only one sterilization parameter (e.g., time or temperature). Multiparameter internal chemical indicators are designed to react to ≥2 parameters (e.g., time and temperature; or time, temperature, and the presence of steam) and can provide a more reliable indication that sterilization conditions have been met (*254*). Multiparameter internal indicators are available only for steam sterilizers (i.e., autoclaves).

Because chemical indicator test results are received when the sterilization cycle is complete, they can provide an early indication of a problem and where in the process the problem might exist. If either mechanical indicators or internal or external chemical indicators indicate inadequate processing, items in the load should not be used until reprocessed (*134*).

Biological indicators (BIs) (i.e., spore tests) are the most accepted method for monitoring the sterilization process (*278,279*) because they assess it directly by killing known highly resistant microorganisms (e.g., *Geobacillus* or *Bacillus* species), rather than merely testing the physical and chemical conditions necessary for sterilization (*243*). Because spores used in BIs are more resistant and present in greater numbers than the common microbial contaminants found on patient-care equipment, an inactivated BI indicates other potential pathogens in the load have been killed (*280*).

Correct functioning of sterilization cycles should be verified for each sterilizer by the periodic use (at least weekly) of BIs (*2,9,134,243,278,279*). Every load containing implantable devices should be monitored with such indicators (*248*), and the items quarantined until BI results are known. However, in an emergency, placing implantable items in quarantine until spore tests are known to be negative might be impossible.

Manufacturer's directions should determine the placement and location of BI in the sterilizer. A control BI, from the same lot as the test indicator and not processed through the sterilizer, should be incubated with the test BI; the control BI should yield positive results for bacterial growth.

In-office biological monitoring is available; mail-in sterilization monitoring services (e.g., from private companies or dental schools) can also be used to test both the BI and the control. Although some DHCP have expressed concern that delays caused by mailing specimens might cause false-negatives, studies have determined that mail delays have no substantial effect on final test results (*281,282*).

Procedures to follow in the event of a positive spore test have been developed (*243,247*). If the mechanical (e.g., time, temperature, and pressure) and chemical (i.e., internal or external) indicators demonstrate that the sterilizer is functioning correctly, a single positive spore test probably does not indicate sterilizer malfunction. Items other than implantable devices do not necessarily need to be recalled; however the spore test should be repeated immediately after correctly loading the sterilizer and using the same cycle that produced the failure. The sterilizer should be removed from service, and all records reviewed of chemical and mechanical monitoring since the last negative BI test. Also, sterilizer operating procedures should be reviewed, including packaging, loading, and spore testing, with all persons who work with the sterilizer to determine whether operator error could be responsible (*9,243,247*).

Overloading, failure to provide adequate package separation, and incorrect or excessive packaging material are all common reasons for a positive BI in the absence of mechanical failure of the sterilizer unit (*260*). A second monitored sterilizer in the office can be used, or a loaner from a sales or repair company obtained, to minimize office disruption while waiting for the repeat BI.

If the repeat test is negative and chemical and mechanical monitoring indicate adequate processing, the sterilizer can be put back into service. If the repeat BI test is positive, and packaging, loading, and operating procedures have been confirmed as performing correctly, the sterilizer should remain out of service until it has been inspected, repaired, and rechallenged with BI tests in three consecutive empty chamber sterilization cycles (*9,243*). When possible, items from suspect loads dating back to the last negative BI should be recalled, rewrapped, and resterilized (*9,283*).

A more conservative approach has been recommended (*247*) in which any positive spore test is assumed to represent sterilizer malfunction and requires that all materials processed in that sterilizer, dating from the sterilization cycle having the last negative biologic indicator to the next cycle indicating satisfactory biologic indicator results, should be considered nonsterile and retrieved, if possible, and reprocessed or held in quarantine until the results of the repeat BI are known. This approach is considered conservative because the margin of safety in steam sterilization is sufficient enough that infection risk, associated with items in a load indicating spore growth, is minimal, particularly if the item was properly cleaned and the temperature was achieved (e.g., as demonstrated by acceptable chemical indicator or temperature chart) (*243*). Published studies are not available that document disease transmission through a nonretrieved surgical instrument after a steam sterilization cycle with a positive biological indicator (*243*). This more conservative approach should always be used for sterilization methods other than steam (e.g., dry heat, unsaturated chemical vapor, ETO, or hydrogen peroxide gas plasma) (*243*).

Results of biological monitoring should be recorded and sterilization monitoring records (i.e., mechanical, chemical, and biological) retained long enough to comply with state and local regulations. Such records are a component of an overall dental infection-control program (see Program Evaluation).

Storage of Sterilized Items and Clean Dental Supplies

The storage area should contain enclosed storage for sterile items and disposable (single-use) items (*173*). Storage practices for wrapped sterilized instruments can be either date- or event-related. Packages containing sterile supplies should be inspected before use to verify barrier integrity and dryness. Although some health-care facilities continue to date every sterilized package and use shelf-life practices, other facilities have switched to event-related practices (*243*). This approach recognizes that the product should remain sterile indefinitely, unless an event causes it to become contaminated (e.g., torn or wet packaging) (*284*). Even for event-related packaging, minimally, the date of sterilization should be placed on the package, and if multiple sterilizers are used in the facility, the sterilizer used should be indicated on the outside of the packaging material to facilitate the retrieval of processed items in the event of a sterilization failure (*247*). If packaging is compromised, the instruments should be recleaned, packaged in new wrap, and sterilized again.

Clean supplies and instruments should be stored in closed or covered cabinets, if possible (*285*). Dental supplies and instruments should not be stored under sinks or in other locations where they might become wet.

Environmental Infection Control

In the dental operatory, environmental surfaces (i.e., a surface or equipment that does not contact patients directly) can become contaminated during patient care. Certain surfaces, especially ones touched frequently (e.g., light handles, unit switches, and drawer knobs) can serve as reservoirs of microbial contamination, although they have not been associated directly with transmission of infection to either DHCP or patients. Transfer of microorganisms from contaminated environmental surfaces to patients occurs primarily through DHCP hand contact (*286,287*). When these surfaces are touched, microbial agents can be transferred to instruments, other environmental surfaces, or to the nose, mouth, or eyes of workers or patients. Although hand hygiene is key to minimizing this transferal, barrier protection or cleaning and disinfecting of environmental surfaces also protects against health-care–associated infections.

Environmental surfaces can be divided into clinical contact surfaces and housekeeping surfaces (*249*). 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 (*244*). 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).

Cleaning is the necessary first step of any disinfection process. Cleaning is a form of decontamination that renders the environmental surface safe by removing organic matter, salts,

and visible soils, all of which interfere with microbial inactivation. The physical action of scrubbing with detergents and surfactants and rinsing with water removes substantial numbers of microorganisms. If a surface is not cleaned first, the success of the disinfection process can be compromised. Removal of all visible blood and inorganic and organic matter can be as critical as the germicidal activity of the disinfecting agent (*249*). When a surface cannot be cleaned adequately, it should be protected with barriers (*2*).

Clinical Contact Surfaces

Clinical contact surfaces can be directly contaminated from patient materials either by direct spray or spatter generated during dental procedures or by contact with DHCP's gloved hands. These surfaces can subsequently contaminate other instruments, devices, hands, or gloves. Examples of such surfaces include

- light handles,
- switches,
- dental radiograph equipment,
- dental chairside computers,
- reusable containers of dental materials,
- drawer handles,
- faucet handles,
- countertops,
- pens,
- telephones, and
- doorknobs.

Barrier protection of surfaces and equipment can prevent contamination of clinical contact surfaces, but is particularly effective for those that are difficult to clean. Barriers include clear plastic wrap, bags, sheets, tubing, and plastic-backed paper or other materials impervious to moisture (*260,288*). Because such coverings can become contaminated, they should be removed and discarded between patients, while DHCP are still gloved. After removing the barrier, examine the surface to make sure it did not become soiled inadvertently. The surface needs to be cleaned and disinfected only if contamination is evident. Otherwise, after removing gloves and performing hand hygiene, DHCP should place clean barriers on these surfaces before the next patient (*1,2,288*).

If barriers are not used, surfaces should be cleaned and disinfected between patients by using an EPA-registered hospital disinfectant with an HIV, HBV claim (i.e., low-level disinfectant) or a tuberculocidal claim (i.e., intermediate-level disinfectant). Intermediate-level disinfectant should be used when the surface is visibly contaminated with blood or OPIM (*2,244*). Also, general cleaning and disinfection are recommended for clinical contact surfaces, dental unit surfaces, and countertops at the end of daily work activities and are required if surfaces have become contaminated since their last cleaning (*13*). To facilitate daily cleaning, treatment areas should be kept free of unnecessary equipment and supplies.

Manufacturers of dental devices and equipment should provide information regarding material compatibility with liquid chemical germicides, whether equipment can be safely immersed for cleaning, and how it should be decontaminated if servicing is required (*289*). Because of the risks associated with exposure to chemical disinfectants and contaminated surfaces, DHCP who perform environmental cleaning and disinfection should wear gloves and other PPE to prevent occupational exposure to infectious agents and hazardous chemicals. Chemical- and puncture-resistant utility gloves offer more protection than patient examination gloves when using hazardous chemicals.

Housekeeping Surfaces

Evidence does not support that housekeeping surfaces (e.g., floors, walls, and sinks) pose a risk for disease transmission in dental health-care settings. Actual, physical removal of microorganisms and soil by wiping or scrubbing is probably as critical, if not more so, than any antimicrobial effect provided by the agent used (*244,290*). The majority of housekeeping surfaces need to be cleaned only with a detergent and water or an EPA-registered hospital disinfectant/detergent, depending on the nature of the surface and the type and degree of contamination. Schedules and methods vary according to the area (e.g., dental operatory, laboratory, bathrooms, or reception rooms), surface, and amount and type of contamination.

Floors should be cleaned regularly, and spills should be cleaned up promptly. An EPA-registered hospital disinfectant/detergent designed for general housekeeping purposes should be used in patient-care areas if uncertainty exists regarding the nature of the soil on the surface (e.g., blood or body fluid contamination versus routine dust or dirt). Unless contamination is reasonably anticipated or apparent, cleaning or disinfecting walls, window drapes, and other vertical surfaces is unnecessary. However, when housekeeping surfaces are visibly contaminated by blood or OPIM, prompt removal and surface disinfection is appropriate infection-control practice and required by OSHA (*13*).

Part of the cleaning strategy is to minimize contamination of cleaning solutions and cleaning tools (e.g., mop heads or cleaning cloths). Mops and cloths should be cleaned after use and allowed to dry before reuse, or single-use, disposable mop heads and cloths should be used to avoid spreading contamination. Cost, safety, product-surface compatibility, and acceptability by housekeepers can be key criteria for selecting a cleaning agent or an EPA-registered hospital disinfectant/

detergent. PPE used during cleaning and housekeeping procedures followed should be appropriate to the task.

In the cleaning process, another reservoir for microorganisms can be dilute solutions of detergents or disinfectants, especially if prepared in dirty containers, stored for long periods of time, or prepared incorrectly (*244*). Manufacturers' instructions for preparation and use should be followed. Making fresh cleaning solution each day, discarding any remaining solution, and allowing the container to dry will minimize bacterial contamination. Preferred cleaning methods produce minimal mists and aerosols or dispersion of dust in patient-care areas.

Cleaning and Disinfection Strategies for Blood Spills

The majority of blood contamination events in dentistry result from spatter during dental procedures using rotary or ultrasonic instrumentation. Although no evidence supports that HBV, HCV, or HIV have been transmitted from a housekeeping surface, prompt removal and surface disinfection of an area contaminated by either blood or OPIM are appropriate infection-control practices and required by OSHA (*13,291*).

Strategies for decontaminating spills of blood and other body fluids differ by setting and volume of the spill (*113,244*). Blood spills on either clinical contact or housekeeping surfaces should be contained and managed as quickly as possible to reduce the risk of contact by patients and DHCP (*244,292*). The person assigned to clean the spill should wear gloves and other PPE as needed. Visible organic material should be removed with absorbent material (e.g., disposable paper towels discarded in a leak-proof, appropriately labeled container). Nonporous surfaces should be cleaned and then decontaminated with either an EPA-registered hospital disinfectant effective against HBV and HIV or an EPA-registered hospital disinfectant with a tuberculocidal claim (i.e., intermediate-level disinfectant). If sodium hypochlorite is chosen, an EPA-registered sodium hypochlorite product is preferred. However, if such products are unavailable, a 1:100 dilution of sodium hypochlorite (e.g., approximately ¼ cup of 5.25% household chlorine bleach to 1 gallon of water) is an inexpensive and effective disinfecting agent (*113*).

Carpeting and Cloth Furnishings

Carpeting is more difficult to clean than nonporous hard-surface flooring, and it cannot be reliably disinfected, especially after spills of blood and body substances. Studies have documented the presence of diverse microbial populations, primarily bacteria and fungi, in carpeting (*293–295*). Cloth furnishings pose similar contamination risks in areas of direct patient care and places where contaminated materials are managed (e.g., dental operatory, laboratory, or instrument processing areas). For these reasons, use of carpeted flooring and fabric-upholstered furnishings in these areas should be avoided.

Nonregulated and Regulated Medical Waste

Studies have compared microbial load and diversity of microorganisms in residential waste with waste from multiple health-care settings. General waste from hospitals or other health-care facilities (e.g., dental practices or clinical/research laboratories) is no more infective than residential waste (*296,297*). The majority of soiled items in dental offices are general medical waste and thus can be disposed of with ordinary waste. Examples include used gloves, masks, gowns, lightly soiled gauze or cotton rolls, and environmental barriers (e.g., plastic sheets or bags) used to cover equipment during treatment (*298*).

Although any item that has had contact with blood, exudates, or secretions might be infective, treating all such waste as infective is neither necessary nor practical (*244*). Infectious waste that carries a substantial risk of causing infection during handling and disposal is regulated medical waste. A complete definition of regulated waste is included in OSHA's bloodborne pathogens standard (*13*).

Regulated medical waste is only a limited subset of waste: 9%–15% of total waste in hospitals and 1%–2% of total waste in dental offices (*298,299*). Regulated medical waste requires special storage, handling, neutralization, and disposal and is covered by federal, state, and local rules and regulations (*6,297,300,301*). Examples of regulated waste found in dental-practice settings are solid waste soaked or saturated with blood or saliva (e.g., gauze saturated with blood after surgery), extracted teeth, surgically removed hard and soft tissues, and contaminated sharp items (e.g., needles, scalpel blades, and wires) (*13*).

Regulated medical waste requires careful containment for treatment or disposal. A single leak-resistant biohazard bag is usually adequate for containment of nonsharp regulated medical waste, provided the bag is sturdy and the waste can be discarded without contaminating the bag's exterior. Exterior contamination or puncturing of the bag requires placement in a second biohazard bag. All bags should be securely closed for disposal. Puncture-resistant containers with a biohazard label, located at the point of use (i.e., sharps containers), are used as containment for scalpel blades, needles, syringes, and unused sterile sharps (*13*).

Dental health-care facilities should dispose of medical waste regularly to avoid accumulation. Any facility generating regulated medical waste should have a plan for its management that complies with federal, state, and local regulations to ensure health and environmental safety.

Discharging Blood or Other Body Fluids to Sanitary Sewers or Septic Tanks

All containers with blood or saliva (e.g., suctioned fluids) can be inactivated in accordance with state-approved treatment technologies, or the contents can be carefully poured down a utility sink, drain, or toilet (*6*). Appropriate PPE (e.g., gloves, gown, mask, and protective eyewear) should be worn when performing this task (*13*). No evidence exists that bloodborne diseases have been transmitted from contact with raw or treated sewage. Multiple bloodborne pathogens, particularly viruses, are not stable in the environment for long periods (*302*), and the discharge of limited quantities of blood and other body fluids into the sanitary sewer is considered a safe method for disposing of these waste materials (*6*). State and local regulations vary and dictate whether blood or other body fluids require pretreatment or if they can be discharged into the sanitary sewer and in what volume.

Dental Unit Waterlines, Biofilm, and Water Quality

Studies have demonstrated that dental unit waterlines (i.e., narrow-bore plastic tubing that carries water to the high-speed handpiece, air/water syringe, and ultrasonic scaler) can become colonized with microorganisms, including bacteria, fungi, and protozoa (*303–309*). Protected by a polysaccharide slime layer known as a glycocalyx, these microorganisms colonize and replicate on the interior surfaces of the waterline tubing and form a biofilm, which serves as a reservoir that can amplify the number of free-floating (i.e., planktonic) microorganisms in water used for dental treatment. Although oral flora (*303,310,311*) and human pathogens (e.g., *Pseudomonas aeruginosa* [*303,305,312,313*], *Legionella* species [*303,306,313*], and nontuberculous *Mycobacterium* species [*303,304*]), have been isolated from dental water systems, the majority of organisms recovered from dental waterlines are common heterotrophic water bacteria (*305,314,315*). These exhibit limited pathogenic potential for immunocompetent persons.

Clinical Implications

Certain reports associate waterborne infections with dental water systems, and scientific evidence verifies the potential for transmission of waterborne infections and disease in hospital settings and in the community (*306,312,316*). Infection or colonization caused by *Pseudomonas* species or nontuberculous mycobacteria can occur among susceptible patients through direct contact with water (*317–320*) or after exposure to residual waterborne contamination of inadequately reprocessed medical instruments (*321–323*). Nontuberculous mycobacteria can also be transmitted to patients from tap water aerosols (*324*). Health-care–associated transmission of pathogenic agents (e.g., *Legionella* species) occurs primarily through inhalation of infectious aerosols generated from potable water sources or through use of tap water in respiratory therapy equipment (*325–327*). Disease outbreaks in the community have also been reported from diverse environmental aerosol-producing sources, including whirlpool spas (*328*), swimming pools (*329*), and a grocery store mist machine (*330*). Although the majority of these outbreaks are associated with species of *Legionella* and *Pseudomonas* (*329*), the fungus *Cladosporium* (*331*) has also been implicated.

Researchers have not demonstrated a measurable risk of adverse health effects among DHCP or patients from exposure to dental water. Certain studies determined DHCP had altered nasal flora (*332*) or substantially greater titers of *Legionella* antibodies in comparisons with control populations; however, no cases of legionellosis were identified among exposed DHCP (*333,334*). Contaminated dental water might have been the source for localized *Pseudomonas aeruginosa* infections in two immunocompromised patients (*312*). Although transient carriage of *P. aeruginosa* was observed in 78 healthy patients treated with contaminated dental treatment water, no illness was reported among the group. In this same study, a retrospective review of dental records also failed to identify infections (*312*).

Concentrations of bacterial endotoxin $\leq$1,000 endotoxin units/mL from gram-negative water bacteria have been detected in water from colonized dental units (*335*). No standards exist for an acceptable level of endotoxin in drinking water, but the maximum level permissible in United States Pharmacopeia (USP) sterile water for irrigation is only 0.25 endotoxin units/mL (*336*). Although the consequences of acute and chronic exposure to aerosolized endotoxin in dental health-care settings have not been investigated, endotoxin has been associated with exacerbation of asthma and onset of hypersensitivity pneumonitis in other occupational settings (*329,337*).

Dental Unit Water Quality

Research has demonstrated that microbial counts can reach $\leq$200,000 colony-forming units (CFU)/mL within 5 days after installation of new dental unit waterlines (*305*), and levels of microbial contamination $\leq 10^6$ CFU/mL of dental unit water have been documented (*309,338*). These counts can occur because dental unit waterline factors (e.g., system design, flow rates, and materials) promote both bacterial growth and development of biofilm.

Although no epidemiologic evidence indicates a public health problem, the presence of substantial numbers of pathogens in dental unit waterlines generates concern. Exposing patients or DHCP to water of uncertain microbiological quality, despite

the lack of documented adverse health effects, is inconsistent with accepted infection-control principles. Thus in 1995, ADA addressed the dental water concern by asking manufacturers to provide equipment with the ability to deliver treatment water with ≤200 CFU/mL of unfiltered output from waterlines (*339*). This threshold was based on the quality assurance standard established for dialysate fluid, to ensure that fluid delivery systems in hemodialysis units have not been colonized by indigenous waterborne organisms (*340*).

Standards also exist for safe drinking water quality as established by EPA, the American Public Health Association (APHA), and the American Water Works Association (AWWA); they have set limits for heterotrophic bacteria of ≤500 CFU/mL of drinking water (*341,342*). Thus, the number of bacteria in water used as a coolant/irrigant for nonsurgical dental procedures should be as low as reasonably achievable and, at a minimum, ≤500 CFU/mL, the regulatory standard for safe drinking water established by EPA and APHA/AWWA.

Strategies To Improve Dental Unit Water Quality

In 1993, CDC recommended that dental waterlines be flushed at the beginning of the clinic day to reduce the microbial load (*2*). However, studies have demonstrated this practice does not affect biofilm in the waterlines or reliably improve the quality of water used during dental treatment (*315,338,343*). Because the recommended value of ≤500 CFU/mL cannot be achieved by using this method, other strategies should be employed. Dental unit water that remains untreated or unfiltered is unlikely to meet drinking water standards (*303–309*). Commercial devices and procedures designed to improve the quality of water used in dental treatment are available (*316*); methods demonstrated to be effective include self-contained water systems combined with chemical treatment, in-line microfilters, and combinations of these treatments. Simply using source water containing ≤500 CFU/mL of bacteria (e.g., tap, distilled, or sterile water) in a self-contained water system will not eliminate bacterial contamination in treatment water if biofilms in the water system are not controlled. Removal or inactivation of dental waterline biofilms requires use of chemical germicides.

Patient material (e.g., oral microorganisms, blood, and saliva) can enter the dental water system during patient treatment (*311,344*). Dental devices that are connected to the dental water system and that enter the patient's mouth (e.g., handpieces, ultrasonic scalers, or air/water syringes) should be operated to discharge water and air for a minimum of 20–30 seconds after each patient (*2*). This procedure is intended to physically flush out patient material that might have entered the turbine, air, or waterlines. The majority of recently manufactured dental units are engineered to prevent retraction of oral fluids, but some older dental units are equipped with antiretraction valves that require periodic maintenance. Users should consult the owner's manual or contact the manufacturer to determine whether testing or maintenance of antiretraction valves or other devices is required. Even with antiretraction valves, flushing devices for a minimum of 20–30 seconds after each patient is recommended.

Maintenance and Monitoring of Dental Unit Water

DHCP should be trained regarding water quality, biofilm formation, water treatment methods, and appropriate maintenance protocols for water delivery systems. Water treatment and monitoring products require strict adherence to maintenance protocols, and noncompliance with treatment regimens has been associated with persistence of microbial contamination in treated systems (*345*). Clinical monitoring of water quality can ensure that procedures are correctly performed and that devices are working in accordance with the manufacturer's previously validated protocol.

Dentists should consult with the manufacturer of their dental unit or water delivery system to determine the best method for maintaining acceptable water quality (i.e., ≤500 CFU/mL) and the recommended frequency of monitoring. Monitoring of dental water quality can be performed by using commercial self-contained test kits or commercial water-testing laboratories. Because methods used to treat dental water systems target the entire biofilm, no rationale exists for routine testing for such specific organisms as *Legionella* or *Pseudomonas*, except when investigating a suspected waterborne disease outbreak (*244*).

Delivery of Sterile Surgical Irrigation

Sterile solutions (e.g., sterile saline or sterile water) should be used as a coolant/irrigation in the performance of oral surgical procedures where a greater opportunity exists for entry of microorganisms, exogenous and endogenous, into the vascular system and other normally sterile areas that support the oral cavity (e.g., bone or subcutaneous tissue) and increased potential exists for localized or systemic infection (see Oral Surgical Procedures). Conventional dental units cannot reliably deliver sterile water even when equipped with independent water reservoirs because the water-bearing pathway cannot be reliably sterilized. Delivery devices (e.g., bulb syringe or sterile, single-use disposable products) should be used to deliver sterile water (*2,121*). Oral surgery and implant handpieces, as well as ultrasonic scalers, are commercially available that bypass the dental unit to deliver sterile water or other solutions by using single-use disposable or sterilizable tubing (*316*).

Boil-Water Advisories

A boil-water advisory is a public health announcement that the public should boil tap water before drinking it. When issued, the public should assume the water is unsafe to drink. Advisories can be issued after 1) failure of or substantial interruption in water treatment processes that result in increased turbidity levels or particle counts and mechanical or equipment failure; 2) positive test results for pathogens (e.g., *Cryptosporidium*, *Giardia*, or *Shigella*) in water; 3) violations of the total coliform rule or the turbidity standard of the surface water treatment rule; 4) circumstances that compromise the distribution system (e.g., watermain break) coupled with an indication of a health hazard; or 5) a natural disaster (e.g., flood, hurricane, or earthquake) (*346*). In recent years, increased numbers of boil-water advisories have resulted from contamination of public drinking water systems with waterborne pathogens. Most notable was the outbreak of cryptosporidiosis in Milwaukee, Wisconsin, where the municipal water system was contaminated with the protozoan parasite *Cryptosporidium parvum*. An estimated 403,000 persons became ill (*347,348*).

During a boil-water advisory, water should not be delivered to patients through the dental unit, ultrasonic scaler, or other dental equipment that uses the public water system. This restriction does not apply if the water source is isolated from the municipal water system (e.g., a separate water reservoir or other water treatment device cleared for marketing by FDA). Patients should rinse with bottled or distilled water until the boil-water advisory has been cancelled. During these advisory periods, tap water should not be used to dilute germicides or for hand hygiene unless the water has been brought to a rolling boil for ≥1 minute and cooled before use (*346,349–351*). For hand hygiene, antimicrobial products that do not require water (e.g., alcohol-based hand rubs) can be used until the boil-water notice is cancelled. If hands are visibly contaminated, bottled water and soap should be used for handwashing; if bottled water is not immediately available, an antiseptic towelette should be used (*13,122*).

When the advisory is cancelled, the local water utility should provide guidance for flushing of waterlines to reduce residual microbial contamination. All incoming waterlines from the public water system inside the dental office (e.g., faucets, waterlines, and dental equipment) should be flushed. No consensus exists regarding the optimal duration for flushing procedures after cancellation of the advisory; recommendations range from 1 to 5 minutes (*244,346,351,352*). The length of time needed can vary with the type and length of the plumbing system leading to the office. After the incoming public water system lines are flushed, dental unit waterlines should be disinfected according to the manufacturer's instructions (*346*).

Special Considerations

Dental Handpieces and Other Devices Attached to Air and Waterlines

Multiple semicritical dental devices that touch mucous membranes are attached to the air or waterlines of the dental unit. Among these devices are high- and low-speed handpieces, prophylaxis angles, ultrasonic and sonic scaling tips, air abrasion devices, and air and water syringe tips. Although no epidemiologic evidence implicates these instruments in disease transmission (*353*), studies of high-speed handpieces using dye expulsion have confirmed the potential for retracting oral fluids into internal compartments of the device (*354–358*). This determination indicates that retained patient material can be expelled intraorally during subsequent uses. Studies using laboratory models also indicate the possibility for retention of viral DNA and viable virus inside both high-speed handpieces and prophylaxis angles (*356,357,359*). The potential for contamination of the internal surfaces of other devices (e.g., low-speed handpieces and ultrasonic scalers), has not been studied, but restricted physical access limits their cleaning. Accordingly, any dental device connected to the dental air/water system that enters the patient's mouth should be run to discharge water, air, or a combination for a minimum of 20–30 seconds after each patient (*2*). This procedure is intended to help physically flush out patient material that might have entered the turbine and air and waterlines (*2,356,357*).

Heat methods can sterilize dental handpieces and other intraoral devices attached to air or waterlines (*246,275,356, 357,360*). For processing any dental device that can be removed from the dental unit air or waterlines, neither surface disinfection nor immersion in chemical germicides is an acceptable method. Ethylene oxide gas cannot adequately sterilize internal components of handpieces (*250,275*). In clinical evaluations of high-speed handpieces, cleaning and lubrication were the most critical factors in determining performance and durability (*361–363*). Manufacturer's instructions for cleaning, lubrication, and sterilization should be followed closely to ensure both the effectiveness of the process and the longevity of handpieces.

Some components of dental instruments are permanently attached to dental unit waterlines and although they do not enter the patient's oral cavity, they are likely to become contaminated with oral fluids during treatment procedures. Such components (e.g., handles or dental unit attachments of saliva ejectors, high-speed air evacuators, and air/water syringes) should be covered with impervious barriers that are changed after each use. If the item becomes visibly contaminated during use, DHCP should clean and disinfect with an EPA-

registered hospital disinfectant (intermediate-level) before use on the next patient.

Saliva Ejectors

Backflow from low-volume saliva ejectors occurs when the pressure in the patient's mouth is less than that in the evacuator. Studies have reported that backflow in low-volume suction lines can occur and microorganisms be present in the lines retracted into the patient's mouth when a seal around the saliva ejector is created (e.g., by a patient closing lips around the tip of the ejector, creating a partial vacuum) (*364–366*). This backflow can be a potential source of cross-contamination; occurrence is variable because the quality of the seal formed varies between patients. Furthermore, studies have demonstrated that gravity pulls fluid back toward the patient's mouth whenever a length of the suction tubing holding the tip is positioned above the patient's mouth, or during simultaneous use of other evacuation (high-volume) equipment (*364–366*). Although no adverse health effects associated with the saliva ejector have been reported, practitioners should be aware that in certain situations, backflow could occur when using a saliva ejector.

Dental Radiology

When taking radiographs, the potential to cross-contaminate equipment and environmental surfaces with blood or saliva is high if aseptic technique is not practiced. Gloves should be worn when taking radiographs and handling contaminated film packets. Other PPE (e.g., mask, protective eyewear, and gowns) should be used if spattering of blood or other body fluids is likely (*11,13,367*). Heat-tolerant versions of intraoral radiograph accessories are available and these semicritical items (e.g., film-holding and positioning devices) should be heat-sterilized before patient use.

After exposure of the radiograph and before glove removal, the film should be dried with disposable gauze or a paper towel to remove blood or excess saliva and placed in a container (e.g., disposable cup) for transport to the developing area. Alternatively, if FDA-cleared film barrier pouches are used, the film packets should be carefully removed from the pouch to avoid contamination of the outside film packet and placed in the clean container for transport to the developing area.

Various methods have been recommended for aseptic transport of exposed films to the developing area, and for removing the outer film packet before exposing and developing the film. Other information regarding dental radiography infection control is available (*260,367,368*). However, care should be taken to avoid contamination of the developing equipment. Protective barriers should be used, or any surfaces that become contaminated should be cleaned and disinfected with an EPA-registered hospital disinfectant of low- (i.e., HIV and HBV claim) to intermediate-level (i.e., tuberculocidal claim) activity. Radiography equipment (e.g., radiograph tubehead and control panel) should be protected with surface barriers that are changed after each patient. If barriers are not used, equipment that has come into contact with DHCP's gloved hands or contaminated film packets should be cleaned and then disinfected after each patient use.

Digital radiography sensors and other high-technology instruments (e.g., intraoral camera, electronic periodontal probe, occlusal analyzers, and lasers) come into contact with mucous membranes and are considered semicritical devices. They should be cleaned and ideally heat-sterilized or high-level disinfected between patients. However, these items vary by manufacturer or type of device in their ability to be sterilized or high-level disinfected. Semicritical items that cannot be reprocessed by heat sterilization or high-level disinfection should, at a minimum, be barrier protected by using an FDA-cleared barrier to reduce gross contamination during use. Use of a barrier does not always protect from contamination (*369–374*). One study determined that a brand of commercially available plastic barriers used to protect dental digital radiography sensors failed at a substantial rate (44%). This rate dropped to 6% when latex finger cots were used in conjunction with the plastic barrier (*375*). To minimize the potential for device-associated infections, after removing the barrier, the device should be cleaned and disinfected with an EPA-registered hospital disinfectant (intermediate-level) after each patient. Manufacturers should be consulted regarding appropriate barrier and disinfection/sterilization procedures for digital radiography sensors, other high-technology intraoral devices, and computer components.

Aseptic Technique for Parenteral Medications

Safe handling of parenteral medications and fluid infusion systems is required to prevent health-care–associated infections among patients undergoing conscious sedation. Parenteral medications can be packaged in single-dose ampules, vials or prefilled syringes, usually without bacteriostatic/preservative agents, and intended for use on a single patient. Multidose vials, used for more than one patient, can have a preservative, but both types of containers of medication should be handled with aseptic techniques to prevent contamination.

Single-dose vials should be used for parenteral medications whenever possible (*376,377*). Single-dose vials might pose a risk for contamination if they are punctured repeatedly. The leftover contents of a single-dose vial should be discarded and

never combined with medications for use on another patient (*376,377*). Medication from a single-dose syringe should not be administered to multiple patients, even if the needle on the syringe is changed (*378*).

The overall risk for extrinsic contamination of multidose vials is probably minimal, although the consequences of contamination might result in life-threatening infection (*379*). If necessary to use a multidose vial, its access diaphragm should be cleansed with 70% alcohol before inserting a sterile device into the vial (*380,381*). A multidose vial should be discarded if sterility is compromised (*380,381*).

Medication vials, syringes, or supplies should not be carried in uniform or clothing pockets. If trays are used to deliver medications to individual patients, they should be cleaned between patients. To further reduce the chance of contamination, all medication vials should be restricted to a centralized medication preparation area separate from the treatment area (*382*).

All fluid infusion and administration sets (e.g., IV bags, tubing, and connections) are single-patient use because sterility cannot be guaranteed when an infusion or administration set is used on multiple patients. Aseptic technique should be used when preparing IV infusion and administration sets, and entry into or breaks in the tubing should be minimized (*378*).

Single-Use or Disposable Devices

A single-use device, also called a disposable device, is designed to be used on one patient and then discarded, not reprocessed for use on another patient (e.g., cleaned, disinfected, or sterilized) (*383*). Single-use devices in dentistry are usually not heat-tolerant and cannot be reliably cleaned. Examples include syringe needles, prophylaxis cups and brushes, and plastic orthodontic brackets. Certain items (e.g., prophylaxis angles, saliva ejectors, high-volume evacuator tips, and air/water syringe tips) are commonly available in a disposable form and should be disposed of appropriately after each use. Single-use devices and items (e.g., cotton rolls, gauze, and irrigating syringes) for use during oral surgical procedures should be sterile at the time of use.

Because of the physical construction of certain devices (e.g., burs, endodontic files, and broaches) cleaning can be difficult. In addition, deterioration can occur on the cutting surfaces of some carbide/diamond burs and endodontic files during processing (*384*) and after repeated processing cycles, leading to potential breakage during patient treatment (*385–388*). These factors, coupled with the knowledge that burs and endodontic instruments exhibit signs of wear during normal use, might make it practical to consider them as single-use devices.

Preprocedural Mouth Rinses

Antimicrobial mouth rinses used by patients before a dental procedure are intended to reduce the number of microorganisms the patient might release in the form of aerosols or spatter that subsequently can contaminate DHCP and equipment operatory surfaces. In addition, preprocedural rinsing can decrease the number of microorganisms introduced in the patient's bloodstream during invasive dental procedures (*389,390*).

No scientific evidence indicates that preprocedural mouth rinsing prevents clinical infections among DHCP or patients, but studies have demonstrated that a preprocedural rinse with an antimicrobial product (e.g., chlorhexidine gluconate, essential oils, or povidone-iodine) can reduce the level of oral microorganisms in aerosols and spatter generated during routine dental procedures with rotary instruments (e.g., dental handpieces or ultrasonic scalers) (*391–399*). Preprocedural mouth rinses can be most beneficial before a procedure that requires using a prophylaxis cup or ultrasonic scaler because rubber dams cannot be used to minimize aerosol and spatter generation and, unless the provider has an assistant, high-volume evacuation is not commonly used (*173*).

The science is unclear concerning the incidence and nature of bacteremias from oral procedures, the relationship of these bacteremias to disease, and the preventive benefit of antimicrobial rinses. In limited studies, no substantial benefit has been demonstrated for mouth rinsing in terms of reducing oral microorganisms in dental-induced bacteremias (*400,401*). However, the American Heart Association's recommendations regarding preventing bacterial endocarditis during dental procedures (*402*) provide limited support concerning preprocedural mouth rinsing with an antimicrobial as an adjunct for patients at risk for bacterial endocarditis. Insufficient data exist to recommend preprocedural mouth rinses to prevent clinical infections among patients or DHCP.

Oral Surgical Procedures

The oral cavity is colonized with numerous microorganisms. Oral surgical procedures present an opportunity for entry of microorganisms (i.e., exogenous and endogenous) into the vascular system and other normally sterile areas of the oral cavity (e.g., bone or subcutaneous tissue); therefore, an increased potential exists for localized or systemic infection. Oral surgical procedures involve the incision, excision, or reflection of tissue that exposes the normally sterile areas of the oral cavity. Examples include biopsy, periodontal surgery, apical surgery, implant surgery, and surgical extractions of teeth (e.g., removal of erupted or nonerupted tooth requiring elevation of mucoperiosteal flap, removal of bone or section of tooth,

and suturing if needed) (see Hand Hygiene, PPE, Single Use or Disposable Devices, and Dental Unit Water Quality).

Handling of Biopsy Specimens

To protect persons handling and transporting biopsy specimens, each specimen must be placed in a sturdy, leakproof container with a secure lid for transportation (*13*). Care should be taken when collecting the specimen to avoid contaminating the outside of the container. If the outside of the container becomes visibly contaminated, it should be cleaned and disinfected or placed in an impervious bag (*2,13*). The container must be labeled with the biohazard symbol during storage, transport, shipment, and disposal (*13,14*).

Handling of Extracted Teeth

Disposal

Extracted teeth that are being discarded are subject to the containerization and labeling provisions outlined by OSHA's bloodborne pathogens standard (*13*). OSHA considers extracted teeth to be potentially infectious material that should be disposed in medical waste containers. Extracted teeth sent to a dental laboratory for shade or size comparisons should be cleaned, surface-disinfected with an EPA-registered hospital disinfectant with intermediate-level activity (i.e., tuberculocidal claim), and transported in a manner consistent with OSHA regulations. However, extracted teeth can be returned to patients on request, at which time provisions of the standard no longer apply (*14*). Extracted teeth containing dental amalgam should not be placed in a medical waste container that uses incineration for final disposal. Commercial metal-recycling companies also might accept extracted teeth with metal restorations, including amalgam. State and local regulations should be consulted regarding disposal of the amalgam.

Educational Settings

Extracted teeth are occasionally collected for use in preclinical educational training. These teeth should be cleaned of visible blood and gross debris and maintained in a hydrated state in a well-constructed closed container during transport. The container should be labeled with the biohazard symbol (*13,14*). Because these teeth will be autoclaved before clinical exercises or study, use of the most economical storage solution (e.g., water or saline) might be practical. Liquid chemical germicides can also be used but do not reliably disinfect both external surface and interior pulp tissue (*403,404*).

Before being used in an educational setting, the teeth should be heat-sterilized to allow safe handling. Microbial growth can be eliminated by using an autoclave cycle for 40 minutes (*405*), but because preclinical educational exercises simulate clinical experiences, students enrolled in dental programs should still follow standard precautions. Autoclaving teeth for preclinical laboratory exercises does not appear to alter their physical properties sufficiently to compromise the learning experience (*405,406*). However, whether autoclave sterilization of extracted teeth affects dentinal structure to the point that the chemical and microchemical relationship between dental materials and the dentin would be affected for research purposes on dental materials is unknown (*406*).

Use of teeth that do not contain amalgam is preferred in educational settings because they can be safely autoclaved (*403,405*). Extracted teeth containing amalgam restorations should not be heat-sterilized because of the potential health hazard from mercury vaporization and exposure. If extracted teeth containing amalgam restorations are to be used, immersion in 10% formalin solution for 2 weeks should be effective in disinfecting both the internal and external structures of the teeth (*403*). If using formalin, manufacturer MSDS should be reviewed for occupational safety and health concerns and to ensure compliance with OSHA regulations (*15*).

Dental Laboratory

Dental prostheses, appliances, and items used in their fabrication (e.g., impressions, occlusal rims, and bite registrations) are potential sources for cross-contamination and should be handled in a manner that prevents exposure of DHCP, patients, or the office environment to infectious agents. Effective communication and coordination between the laboratory and dental practice will ensure that appropriate cleaning and disinfection procedures are performed in the dental office or laboratory, materials are not damaged or distorted because of disinfectant overexposure, and effective disinfection procedures are not unnecessarily duplicated (*407,408*).

When a laboratory case is sent off-site, DHCP should provide written information regarding the methods (e.g., type of disinfectant and exposure time) used to clean and disinfect the material (e.g., impression, stone model, or appliance) (*2,407,409*). Clinical materials that are not decontaminated are subject to OSHA and U.S. Department of Transportation regulations regarding transportation and shipping of infectious materials (*13,410*).

Appliances and prostheses delivered to the patient should be free of contamination. Communication between the laboratory and the dental practice is also key at this stage to determine which one is responsible for the final disinfection process. If the dental laboratory staff provides the disinfection, an EPA-registered hospital disinfectant (low to intermediate) should be used, written documentation of the disinfection method

provided, and the item placed in a tamper-evident container before returning it to the dental office. If such documentation is not provided, the dental office is responsible for final disinfection procedures.

Dental prostheses or impressions brought into the laboratory can be contaminated with bacteria, viruses, and fungi (*411,412*). Dental prostheses, impressions, orthodontic appliances, and other prosthodontic materials (e.g., occlusal rims, temporary prostheses, bite registrations, or extracted teeth) should be thoroughly cleaned (i.e., blood and bioburden removed), disinfected with an EPA-registered hospital disinfectant with a tuberculocidal claim, and thoroughly rinsed before being handled in the in-office laboratory or sent to an off-site laboratory (*2,244,249,407*). The best time to clean and disinfect impressions, prostheses, or appliances is as soon as possible after removal from the patient's mouth before drying of blood or other bioburden can occur. Specific guidance regarding cleaning and disinfecting techniques for various materials is available (*260,413–416*). DHCP are advised to consult with manufacturers regarding the stability of specific materials during disinfection.

In the laboratory, a separate receiving and disinfecting area should be established to reduce contamination in the production area. Bringing untreated items into the laboratory increases chances for cross infection (*260*). If no communication has been received regarding prior cleaning and disinfection of a material, the dental laboratory staff should perform cleaning and disinfection procedures before handling. If during manipulation of a material or appliance a previously undetected area of blood or bioburden becomes apparent, cleaning and disinfection procedures should be repeated. Transfer of oral microorganisms into and onto impressions has been documented (*417–419*). Movement of these organisms onto dental casts has also been demonstrated (*420*). Certain microbes have been demonstrated to remain viable within gypsum cast materials for ≤7 days (*421*). Incorrect handling of contaminated impressions, prostheses, or appliances, therefore, offers an opportunity for transmission of microorganisms (*260*). Whether in the office or laboratory, PPE should be worn until disinfection is completed (*1,2,7,10,13*).

If laboratory items (e.g., burs, polishing points, rag wheels, or laboratory knives) are used on contaminated or potentially contaminated appliances, prostheses, or other material, they should be heat-sterilized, disinfected between patients, or discarded (i.e., disposable items should be used) (*260,407*). Heat-tolerant items used in the mouth (e.g., metal impression tray or face bow fork) should be heat-sterilized before being used on another patient (*2,407*). Items that do not normally contact the patient, prosthetic device, or appliance but frequently become contaminated and cannot withstand heat-sterilization (e.g., articulators, case pans, or lathes) should be cleaned and disinfected between patients and according to the manufacturer's instructions. Pressure pots and water baths are particularly susceptible to contamination with microorganisms and should be cleaned and disinfected between patients (*422*). In the majority of instances, these items can be cleaned and disinfected with an EPA-registered hospital disinfectant. Environmental surfaces should be barrier-protected or cleaned and disinfected in the same manner as in the dental treatment area.

Unless waste generated in the dental laboratory (e.g., disposable trays or impression materials) falls under the category of regulated medical waste, it can be discarded with general waste. Personnel should dispose of sharp items (e.g., burs, disposable blades, and orthodontic wires) in puncture-resistant containers.

Laser/Electrosurgery Plumes or Surgical Smoke

During surgical procedures that use a laser or electrosurgical unit, the thermal destruction of tissue creates a smoke byproduct. Laser plumes or surgical smoke represent another potential risk for DHCP (*423–425*). Lasers transfer electromagnetic energy into tissues, resulting in the release of a heated plume that includes particles, gases (e.g., hydrogen cyanide, benzene, and formaldehyde), tissue debris, viruses, and offensive odors. One concern is that aerosolized infectious material in the laser plume might reach the nasal mucosa of the laser operator and adjacent DHCP. Although certain viruses (e.g., varicella-zoster virus and herpes simplex virus) appear not to aerosolize efficiently (*426,427*), other viruses and various bacteria (e.g., human papilloma virus, HIV, coagulase-negative *Staphylococcus*, *Corynebacterium* species, and *Neisseria* species) have been detected in laser plumes (*428–434*). However, the presence of an infectious agent in a laser plume might not be sufficient to cause disease from airborne exposure, especially if the agent's normal mode of transmission is not airborne. No evidence indicates that HIV or HBV have been transmitted through aerosolization and inhalation (*435*). Although continuing studies are needed to evaluate the risk for DHCP of laser plumes and electrosurgery smoke, following NIOSH recommendations (*425*) and practices developed by the Association of periOperative Registered Nurses (AORN) might be practical (*436*). These practices include using 1) standard precautions (e.g., high-filtration surgical masks and possibly full face shields) (*437*); 2) central room suction units with in-line filters to collect particulate matter from minimal plumes; and 3) dedicated mechanical smoke exhaust systems with a high-efficiency filter to remove substantial amounts of laser plume particles. Local smoke evacuation systems have been recom-

mended by consensus organizations, and these systems can improve the quality of the operating field. Employers should be aware of this emerging problem and advise employees of the potential hazards of laser smoke (*438*). However, this concern remains unresolved in dental practice and no recommendation is provided here.

M. tuberculosis

Patients infected with *M. tuberculosis* occasionally seek urgent dental treatment at outpatient dental settings. Understanding the pathogenesis of the development of TB will help DHCP determine how to manage such patients.

M. tuberculosis is a bacterium carried in airborne infective droplet nuclei that can be generated when persons with pulmonary or laryngeal TB sneeze, cough, speak, or sing (*439*). These small particles (1–5 µm) can stay suspended in the air for hours (*440*). Infection occurs when a susceptible person inhales droplet nuclei containing *M. tuberculosis*, which then travel to the alveoli of the lungs. Usually within 2–12 weeks after initial infection with *M. tuberculosis*, immune response prevents further spread of the TB bacteria, although they can remain alive in the lungs for years, a condition termed latent TB infection. Persons with latent TB infection usually exhibit a reactive tuberculin skin test (TST), have no symptoms of active disease, and are not infectious. However, they can develop active disease later in life if they do not receive treatment for their latent infection.

Approximately 5% of persons who have been recently infected and not treated for latent TB infection will progress from infection to active disease during the first 1–2 years after infection; another 5% will develop active disease later in life. Thus, approximately 90% of U.S. persons with latent TB infection do not progress to active TB disease. Although both latent TB infection and active TB disease are described as TB, only the person with active disease is contagious and presents a risk of transmission. Symptoms of active TB disease include a productive cough, night sweats, fatigue, malaise, fever, and unexplained weight loss. Certain immunocompromising medical conditions (e.g., HIV) increase the risk that TB infection will progress to active disease at a faster rate (*441*).

Overall, the risk borne by DHCP for exposure to a patient with active TB disease is probably low (*20,21*). Only one report exists of TB transmission in a dental office (*442*), and TST conversions among DHCP are also low (*443,444*). However, in certain cases, DHCP or the community served by the dental facility might be at relatively high risk for exposure to TB.

Surgical masks do not prevent inhalation of *M. tuberculosis* droplet nuclei, and therefore, standard precautions are not sufficient to prevent transmission of this organism. Recommendations for expanded precautions to prevent transmission of *M. tuberculosis* and other organisms that can be spread by airborne, droplet, or contact routes have been detailed in other guidelines (*5,11,20*).

TB transmission is controlled through a hierarchy of measures, including administrative controls, environmental controls, and personal respiratory protection. The main administrative goals of a TB infection-control program are early detection of a person with active TB disease and prompt isolation from susceptible persons to reduce the risk of transmission. Although DHCP are not responsible for diagnosis and treatment of TB, they should be trained to recognize signs and symptoms to help with prompt detection. Because potential for transmission of *M. tuberculosis* exists in outpatient settings, dental practices should develop a TB control program appropriate for their level of risk (*20,21*).

- A community risk assessment should be conducted periodically, and TB infection-control policies for each dental setting should be based on the risk assessment. The policies should include provisions for detection and referral of patients who might have undiagnosed active TB; management of patients with active TB who require urgent dental care; and DHCP education, counseling, and TST screening.
- DHCP who have contact with patients should have a baseline TST, preferably by using a two-step test at the beginning of employment. The facility's level of TB risk will determine the need for routine follow-up TST.
- While taking patients' initial medical histories and at periodic updates, dental DHCP should routinely ask all patients whether they have a history of TB disease or symptoms indicative of TB.
- Patients with a medical history or symptoms indicative of undiagnosed active TB should be referred promptly for medical evaluation to determine possible infectiousness. Such patients should not remain in the dental-care facility any longer than required to evaluate their dental condition and arrange a referral. While in the dental health-care facility, the patient should be isolated from other patients and DHCP, wear a surgical mask when not being evaluated, or be instructed to cover their mouth and nose when coughing or sneezing.
- Elective dental treatment should be deferred until a physician confirms that a patient does not have infectious TB, or if the patient is diagnosed with active TB disease, until confirmed the patient is no longer infectious.
- If urgent dental care is provided for a patient who has, or is suspected of having active TB disease, the care should be provided in a facility (e.g., hospital) that provides airborne infection isolation (i.e., using such engineering con-

trols as TB isolation rooms, negatively pressured relative to the corridors, with air either exhausted to the outside or HEPA-filtered if recirculation is necessary). Standard surgical face masks do not protect against TB transmission; DHCP should use respiratory protection (e.g., fit-tested, disposable N-95 respirators).

- Settings that do not require use of respiratory protection because they do not treat active TB patients and do not perform cough-inducing procedures on potential active TB patients do not need to develop a written respiratory protection program.
- Any DHCP with a persistent cough (i.e., lasting >3 weeks), especially in the presence of other signs or symptoms compatible with active TB (e.g., weight loss, night sweats, fatigue, bloody sputum, anorexia, or fever), should be evaluated promptly. The DHCP should not return to the workplace until a diagnosis of TB has been excluded or the DHCP is on therapy and a physician has determined that the DHCP is noninfectious.

Creutzfeldt-Jakob Disease and Other Prion Diseases

Creutzfeldt-Jakob disease (CJD) belongs to a group of rapidly progressive, invariably fatal, degenerative neurological disorders, transmissible spongiform encephalopathies (TSEs) that affect both humans and animals and are thought to be caused by infection with an unusual pathogen called a prion. Prions are isoforms of a normal protein, capable of self-propagation although they lack nucleic acid. Prion diseases have an incubation period of years and are usually fatal within 1 year of diagnosis.

Among humans, TSEs include CJD, Gerstmann-Straussler-Scheinker syndrome, fatal familial insomnia, kuru, and variant CJD (vCJD). Occurring in sporadic, familial, and acquired (i.e., iatrogenic) forms, CJD has an annual incidence in the United States and other countries of approximately 1 case/million population (*445–448*). In approximately 85% of affected patients, CJD occurs as a sporadic disease with no recognizable pattern of transmission. A smaller proportion of patients (5%–15%) experience familial CJD because of inherited mutations of the prion protein gene (*448*).

vCJD is distinguishable clinically and neuropathologically from classic CJD, and strong epidemiologic and laboratory evidence indicates a causal relationship with bovine spongiform encephalopathy (BSE), a progressive neurological disorder of cattle commonly known as *mad cow disease* (*449–451*). vCJD, was reported first in the United Kingdom in 1996 (*449*) and subsequently in other European countries (*452*). Only one case of vCJD has been reported in the United States, in an immigrant from the United Kingdom (*453*). Compared with CJD patients, those with vCJD are younger (28 years versus 68 years median age at death), and have a longer duration of illness (13 months versus 4.5 months). Also, vCJD patients characteristically exhibit sensory and psychiatric symptoms that are uncommon with CJD. Another difference includes the ease with which the presence of prions is consistently demonstrated in lymphoreticular tissues (e.g., tonsil) in vCJD patients by immunohistochemistry (*454*).

CJD and vCJD are transmissible diseases, but not through the air or casual contact. All known cases of iatrogenic CJD have resulted from exposure to infected central nervous tissue (e.g., brain and dura mater), pituitary, or eye tissue. Studies in experimental animals have determined that other tissues have low or no detectable infectivity (*243,455,456*). Limited experimental studies have demonstrated that scrapie (a TSE in sheep) can be transmitted to healthy hamsters and mice by exposing oral tissues to infectious homogenate (*457,458*). These animal models and experimental designs might not be directly applicable to human transmission and clinical dentistry, but they indicate a theoretical risk of transmitting prion diseases through perioral exposures.

According to published reports, iatrogenic transmission of CJD has occurred in humans under three circumstances: after use of contaminated electroencephalography depth electrodes and neurosurgical equipment (*459*); after use of extracted pituitary hormones (*460,461*); and after implant of contaminated corneal (*462*) and dura mater grafts (*463,464*) from humans. The equipment-related cases occurred before the routine implementation of sterilization procedures used in healthcare facilities.

Case-control studies have found no evidence that dental procedures increase the risk of iatrogenic transmission of TSEs among humans. In these studies, CJD transmission was not associated with dental procedures (e.g., root canals or extractions), with convincing evidence of prion detection in human blood, saliva, or oral tissues, or with DHCP becoming occupationally infected with CJD (*465–467*). In 2000, prions were not found in the dental pulps of eight patients with neuropathologically confirmed sporadic CJD by using electrophoresis and a Western blot technique (*468*).

Prions exhibit unusual resistance to conventional chemical and physical decontamination procedures. Considering this resistance and the invariably fatal outcome of CJD, procedures for disinfecting and sterilizing instruments potentially contaminated with the CJD prion have been controversial for years. Scientific data indicate the risk, if any, of sporadic CJD transmission during dental and oral surgical procedures is low to nil. Until additional information exists regarding the transmissibility of CJD or vCJD, special precautions in addition to

standard precautions might be indicated when treating known CJD or vCJD patients; the following list of precautions is provided for consideration without recommendation (*243,249,277,469*):

- Use single-use disposable items and equipment whenever possible.
- Consider items difficult to clean (e.g., endodontic files, broaches, and carbide and diamond burs) as single-use disposables and discard after one use.
- To minimize drying of tissues and body fluids on a device, keep the instrument moist until cleaned and decontaminated.
- Clean instruments thoroughly and steam-autoclave at 134°C for 18 minutes. This is the least stringent of sterilization methods offered by the World Health Organization. The complete list (*469*) is available at http://www.who.int/emc-documents/tse/whocdscsraph2003c.html.
- Do not use flash sterilization for processing instruments or devices.

Potential infectivity of oral tissues in CJD or vCJD patients is an unresolved concern. CDC maintains an active surveillance program on CJD. Additional information and resources are available at http://www.cdc.gov/ncidod/diseases/cjd/cjd.htm.

Program Evaluation

The goal of a dental infection-control program is to provide a safe working environment that will reduce the risk of health-care–associated infections among patients and occupational exposures among DHCP. Medical errors are caused by faulty systems, processes, and conditions that lead persons to make mistakes or fail to prevent errors being made by others (*470*). Effective program evaluation is a systematic way to ensure procedures are useful, feasible, ethical, and accurate. Program evaluation is an essential organizational practice; however, such evaluation is not practiced consistently across program areas, nor is it sufficiently well-integrated into the day-to-day management of the majority of programs (*471*).

A successful infection-control program depends on developing standard operating procedures, evaluating practices, routinely documenting adverse outcomes (e.g., occupational exposures to blood) and work-related illnesses in DHCP, and monitoring health-care–associated infections in patients. Strategies and tools to evaluate the infection-control program can include periodic observational assessments, checklists to document procedures, and routine review of occupational exposures to bloodborne pathogens. Evaluation offers an opportunity to improve the effectiveness of both the infection-control program and dental-practice protocols. If deficiencies or problems in the implementation of infection-control procedures are identified, further evaluation is needed to eliminate the problems. Examples of infection-control program evaluation activities are provided (Table 5).

TABLE 5. Examples of methods for evaluating infection-control programs

Program element	Evaluation activity
Appropriate immunization of dental health-care personnel (DHCP).	Conduct annual review of personnel records to ensure up-to-date immunizations.
Assessment of occupational exposures to infectious agents.	Report occupational exposures to infectious agents. Document the steps that occurred around the exposure and plan how such exposure can be prevented in the future.
Comprehensive postexposure management plan and medical follow-up program after occupational exposures to infectious agents.	Ensure the postexposure management plan is clear, complete, and available at all times to all DHCP. All staff should understand the plan, which should include toll-free phone numbers for access to additional information.
Adherence to hand hygiene before and after patient care.	Observe and document circumstances of appropriate or inappropriate handwashing. Review findings in a staff meeting.
Proper use of personal protective equipment to prevent occupational exposures to infectious agents.	Observe and document the use of barrier precautions and careful handling of sharps. Review findings in a staff meeting.
Routine and appropriate sterilization of instruments using a biologic monitoring system.	Monitor paper log of steam cycle and temperature strip with each sterilization load, and examine results of weekly biologic monitoring. Take appropriate action when failure of sterilization process is noted.
Evaluation and implementation of safer medical devices.	Conduct an annual review of the exposure control plan and consider new developments in safer medical devices.
Compliance of water in routine dental procedures with current drinking U.S. Environmental Protection Agency water standards (fewer than 500 CFU of heterotrophic water bacteria).	Monitor dental water quality as recommended by the equipment manufacturer, using commercial self-contained test kits, or commercial water-testing laboratories.
Proper handling and disposal of medical waste.	Observe the safe disposal of regulated and nonregulated medical waste and take preventive measures if hazardous situations occur.
Health-care–associated infections.	Assess the unscheduled return of patients after procedures and evaluate them for an infectious process. A trend might require formal evaluation.

Infection-Control Research Considerations

Although the number of published studies concerning dental infection control has increased in recent years, questions regarding infection-control practices and their effectiveness remain unanswered. Multiple concerns were identified by the working group for this report, as well as by others during the public comment period (Box). This list is not exhaustive and does not represent a CDC research agenda, but rather is an effort to identify certain concerns, stimulate discussion, and provide direction for determining future action by clinical, basic science, and epidemiologic investigators, as well as health and professional organizations, clinicians, and policy makers.

BOX. Dental infection-control research considerations

Education and promotion
- Design strategies to communicate, to the public and providers, the risk of disease transmission in dentistry.
- Promote use of protocols for recommended postexposure management and follow-up.
- Educate and train dental health-care personnel (DHCP) to screen and evaluate safer dental devices by using tested design and performance criteria.

Laboratory-based research
- Develop animal models to determine the risk of transmitting organisms through inhalation of contaminated aerosols (e.g., influenza) produced from rotary dental instruments.
- Conduct studies to determine the effectiveness of gloves (i.e., material compatibility and duration of use).
- Develop devices with passive safety features to prevent percutaneous injuries.
- Study the effect of alcohol-based hand-hygiene products on retention of latex proteins and other dental allergens (e.g., methylmethacrylate, glutaraldehyde, thiurams) on the hands of DHCP after latex glove use.
- Investigate the applicability of other types of sterilization procedures (e.g., hydrogen peroxide gas plasma) in dentistry.
- Encourage manufacturers to determine optimal methods and frequency for testing dental-unit waterlines and maintaining dental-unit water-quality standards.
- Determine the potential for internal contamination of low-speed handpieces, including the motor, and other devices connected to dental air and water supplies, as well as more efficient ways to clean, lubricate, and sterilize handpieces and other devices attached to air or waterlines.
- Investigate the infectivity of oral tissues in Creutzfeldt-Jakob disease (CJD) or variant CJD patients.
- Determine the most effective methods to disinfect dental impression materials.
- Investigate the viability of pathogenic organisms on dental materials (e.g., impression materials, acrylic resin, or gypsum materials) and dental laboratory equipment.
- Determine the most effective methods for sterilization or disinfection of digital radiology equipment.
- Evaluate the effects of repetitive reprocessing cycles on burs and endodontic files.
- Investigate the potential infectivity of vapors generated from the various lasers used for oral procedures.

Clinical and population-based epidemiologic research and development
- Continue to characterize the epidemiology of blood contacts, particularly percutaneous injuries, and the effectiveness of prevention measures.
- Further assess the effectiveness of double gloving in preventing blood contact during routine and surgical dental procedures.
- Continue to assess the stress placed on gloves during dental procedures and the potential for developing defects during different procedures.
- Develop methods for evaluating the effectiveness and cost-effectiveness of infection-control interventions.
- Determine how infection-control guidelines affect the knowledge, attitudes, and practices of DHCP.

Recommendations

Each recommendation is categorized on the basis of existing scientific data, theoretical rationale, and applicability. Rankings are based on the system used by CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC) to categorize recommendations:

Category IA. Strongly recommended for implementation and strongly supported by well-designed experimental, clinical, or epidemiologic studies.

Category IB. Strongly recommended for implementation and supported by experimental, clinical, or epidemiologic studies and a strong theoretical rationale.

Category IC. Required for implementation as mandated by federal or state regulation or standard. When IC is used, a second rating can be included to provide the basis of existing scientific data, theoretical rationale, and applicability. Because of state differences, the reader should not assume that the absence of a IC implies the absence of state regulations.

Category II. Suggested for implementation and supported by suggestive clinical or epidemiologic studies or a theoretical rationale.

Unresolved issue. No recommendation. Insufficient evidence or no consensus regarding efficacy exists.

I. Personnel Health Elements of an Infection-Control Program

A. General Recommendations

1. Develop a written health program for DHCP that includes policies, procedures, and guidelines for education and training; immunizations; exposure prevention and postexposure management; medical conditions, work-related illness, and associated work restrictions; contact dermatitis and latex hypersensitivity; and maintenance of records, data management, and confidentiality (IB) (*5,16–18,22*).
2. Establish referral arrangements with qualified health-care professionals to ensure prompt and appropriate provision of preventive services, occupationally related medical services, and postexposure management with medical follow-up (IB, IC) (*5,13,19,22*).

B. Education and Training

1. Provide DHCP 1) on initial employment, 2) when new tasks or procedures affect the employee's occupational exposure, and 3) at a minimum, annually, with education and training regarding occupational exposure to potentially infectious agents and infection-control procedures/protocols appropriate for and specific to their assigned duties (IB, IC) (*5,11,13,14,16,19,22*).
2. Provide educational information appropriate in content and vocabulary to the educational level, literacy, and language of DHCP (IB, IC) (*5,13*).

C. Immunization Programs

1. Develop a written comprehensive policy regarding immunizing DHCP, including a list of all required and recommended immunizations (IB) (*5,17,18*).
2. Refer DHCP to a prearranged qualified health-care professional or to their own health-care professional to receive all appropriate immunizations based on the latest recommendations as well as their medical history and risk for occupational exposure (IB) (*5,17*).

D. Exposure Prevention and Postexposure Management

1. Develop a comprehensive postexposure management and medical follow-up program (IB, IC) (*5,13,14,19*).
   a. Include policies and procedures for prompt reporting, evaluation, counseling, treatment, and medical follow-up of occupational exposures.
   b. Establish mechanisms for referral to a qualified health-care professional for medical evaluation and follow-up.
   c. Conduct a baseline TST, preferably by using a two-step test, for all DHCP who might have contact with persons with suspected or confirmed infectious TB, regardless of the risk classification of the setting (IB) (*20*).

E. Medical Conditions, Work-Related Illness, and Work Restrictions

1. Develop and have readily available to all DHCP comprehensive written policies regarding work restriction and exclusion that include a statement of authority defining who can implement such policies (IB) (*5,22*).
2. Develop policies for work restriction and exclusion that encourage DHCP to seek appropriate preventive and curative care and report their illnesses, medical conditions, or treatments that can render them more susceptible to opportunistic infection or exposures; do not penalize DHCP with loss of wages, benefits, or job status (IB) (*5,22*).

3. Develop policies and procedures for evaluation, diagnosis, and management of DHCP with suspected or known occupational contact dermatitis (IB) (*32*).
4. Seek definitive diagnosis by a qualified healthcare professional for any DHCP with suspected latex allergy to carefully determine its specific etiology and appropriate treatment as well as work restrictions and accommodations (IB) (*32*).

F. **Records Maintenance, Data Management, and Confidentiality**

1. Establish and maintain confidential medical records (e.g., immunization records and documentation of tests received as a result of occupational exposure) for all DHCP (IB, IC) (*5,13*).
2. Ensure that the practice complies with all applicable federal, state, and local laws regarding medical recordkeeping and confidentiality (IC) (*13,34*).

II. Preventing Transmission of Bloodborne Pathogens

A. **HBV Vaccination**

1. Offer the HBV vaccination series to all DHCP with potential occupational exposure to blood or other potentially infectious material (IA, IC) (*2,13,14,19*).
2. Always follow U.S. Public Health Service/CDC recommendations for hepatitis B vaccination, serologic testing, follow-up, and booster dosing (IA, IC) (*13,14,19*).
3. Test DHCP for anti-HBs 1–2 months after completion of the 3-dose vaccination series (IA, IC) (*14,19*).
4. DHCP should complete a second 3-dose vaccine series or be evaluated to determine if they are HBsAg-positive if no antibody response occurs to the primary vaccine series (IA, IC) (*14,19*).
5. Retest for anti-HBs at the completion of the second vaccine series. If no response to the second 3-dose series occurs, nonresponders should be tested for HBsAg (IC) (*14,19*).
6. Counsel nonresponders to vaccination who are HBsAg-negative regarding their susceptibility to HBV infection and precautions to take (IA, IC) (*14,19*).
7. Provide employees appropriate education regarding the risks of HBV transmission and the availability of the vaccine. Employees who decline the vaccination should sign a declination form to be kept on file with the employer (IC) (*13*).

B. **Preventing Exposures to Blood and OPIM**

1. General recommendations
   a. Use standard precautions (OSHA's bloodborne pathogen standard retains the term universal precautions) for all patient encounters (IA, IC) (*11,13,19,53*).
   b. Consider sharp items (e.g., needles, scalers, burs, lab knives, and wires) that are contaminated with patient blood and saliva as potentially infective and establish engineering controls and work practices to prevent injuries (IB, IC) (*6,13,113*).
   c. Implement a written, comprehensive program designed to minimize and manage DHCP exposures to blood and body fluids (IB, IC). (*13,14,19,97*).
2. Engineering and work-practice controls
   a. Identify, evaluate, and select devices with engineered safety features at least annually and as they become available on the market (e.g., safer anesthetic syringes, blunt suture needle, retractable scalpel, or needleless IV systems) (IC) (*13,97,110–112*).
   b. Place used disposable syringes and needles, scalpel blades, and other sharp items in appropriate puncture-resistant containers located as close as feasible to the area in which the items are used (IA, IC) (*2,7,13,19,113,115*).
   c. Do not recap used needles by using both hands or any other technique that involves directing the point of a needle toward any part of the body. Do not bend, break, or remove needles before disposal (IA, IC) (*2,7,8,13,97,113*).
   d. Use either a one-handed scoop technique or a mechanical device designed for holding the needle cap when recapping needles (e.g., between multiple injections and before removing from a nondisposable aspirating syringe) (IA, IC) (*2,7,8,13,14,113*).
3. Postexposure management and prophylaxis
   a. Follow CDC recommendations after percutaneous, mucous membrane, or nonintact skin exposure to blood or other potentially infectious material (IA, IC) (*13,14,19*).

III. Hand Hygiene

A. General Considerations

1. Perform hand hygiene with either a nonantimicrobial or antimicrobial soap and water when hands are visibly dirty or contaminated with blood or other potentially infectious material. If hands are not visibly soiled, an alcohol-based hand rub can also be used. Follow the manufacturer's instructions (IA) (*123*).
2. Indications for hand hygiene include
   a. when hands are visibly soiled (IA, IC);
   b. after barehanded touching of inanimate objects likely to be contaminated by blood, saliva, or respiratory secretions (IA, IC);
   c. before and after treating each patient (IB);
   d. before donning gloves (IB); and
   e. immediately after removing gloves (IB, IC) (*7–9,11,13,113,120–123,125,126,138*).
3. For oral surgical procedures, perform surgical hand antisepsis before donning sterile surgeon's gloves. Follow the manufacturer's instructions by using either an antimicrobial soap and water, or soap and water followed by drying hands and application of an alcohol-based surgical hand-scrub product with persistent activity (IB) (*121–123,127–133,144,145*).
4. Store liquid hand-care products in either disposable closed containers or closed containers that can be washed and dried before refilling. Do not add soap or lotion to (i.e., top off) a partially empty dispenser (IA) (*9,120,122,149,150*).

B. Special Considerations for Hand Hygiene and Glove Use

1. Use hand lotions to prevent skin dryness associated with handwashing (IA) (*153,154*).
2. Consider the compatibility of lotion and antiseptic products and the effect of petroleum or other oil emollients on the integrity of gloves during product selection and glove use (IB) (*2,14,122,155*).
3. Keep fingernails short with smooth, filed edges to allow thorough cleaning and prevent glove tears (II) (*122,123,156*).
4. Do not wear artificial fingernails or extenders when having direct contact with patients at high risk (e.g., those in intensive care units or operating rooms) (IA) (*123,157–160*).
5. Use of artificial fingernails is usually not recommended (II) (*157–160*).
6. Do not wear hand or nail jewelry if it makes donning gloves more difficult or compromises the fit and integrity of the glove (II) (*123,142,143*).

IV. PPE

A. Masks, Protective Eyewear, and Face Shields

1. Wear a surgical mask and eye protection with solid side shields or a face shield to protect mucous membranes of the eyes, nose, and mouth during procedures likely to generate splashing or spattering of blood or other body fluids (IB, IC) (*1,2,7,8,11,13,137*).
2. Change masks between patients or during patient treatment if the mask becomes wet (IB) (*2*).
3. Clean with soap and water, or if visibly soiled, clean and disinfect reusable facial protective equipment (e.g., clinician and patient protective eyewear or face shields) between patients (II) (*2*).

B. Protective Clothing

1. Wear protective clothing (e.g., reusable or disposable gown, laboratory coat, or uniform) that covers personal clothing and skin (e.g., forearms) likely to be soiled with blood, saliva, or OPIM (IB, IC) (*7,8,11,13,137*).
2. Change protective clothing if visibly soiled (*134*); change immediately or as soon as feasible if penetrated by blood or other potentially infectious fluids (IB, IC) (*13*).
3. Remove barrier protection, including gloves, mask, eyewear, and gown before departing work area (e.g., dental patient care, instrument processing, or laboratory areas) (IC) (*13*).

C. Gloves

1. Wear medical gloves when a potential exists for contacting blood, saliva, OPIM, or mucous membranes (IB, IC) (*1,2,7,8,13*).
2. Wear a new pair of medical gloves for each patient, remove them promptly after use, and wash hands immediately to avoid transfer of microorganisms to other patients or environments (IB) (*1,7,8,123*).
3. Remove gloves that are torn, cut, or punctured as soon as feasible and wash hands before regloving (IB, IC) (*13,210,211*).
4. Do not wash surgeon's or patient examination gloves before use or wash, disinfect, or sterilize gloves for reuse (IB, IC) (*13,138,177,212,213*).

5. Ensure that appropriate gloves in the correct size are readily accessible (IC) (*13*).
6. Use appropriate gloves (e.g., puncture- and chemical-resistant utility gloves) when cleaning instruments and performing housekeeping tasks involving contact with blood or OPIM (IB, IC) (*7,13,15*).
7. Consult with glove manufacturers regarding the chemical compatibility of glove material and dental materials used (II).

D. Sterile Surgeon's Gloves and Double Gloving During Oral Surgical Procedures

1. Wear sterile surgeon's gloves when performing oral surgical procedures (IB) (*2,8,137*).
2. No recommendation is offered regarding the effectiveness of wearing two pairs of gloves to prevent disease transmission during oral surgical procedures. The majority of studies among HCP and DHCP have demonstrated a lower frequency of inner glove perforation and visible blood on the surgeon's hands when double gloves are worn; however, the effectiveness of wearing two pairs of gloves in preventing disease transmission has not been demonstrated (Unresolved issue).

V. Contact Dermatitis and Latex Hypersensitivity

A. General Recommendations

1. Educate DHCP regarding the signs, symptoms, and diagnoses of skin reactions associated with frequent hand hygiene and glove use (IB) (*5,31,32*).
2. Screen all patients for latex allergy (e.g., take health history and refer for medical consultation when latex allergy is suspected) (IB) (*32*).
3. Ensure a latex-safe environment for patients and DHCP with latex allergy (IB) (*32*).
4. Have emergency treatment kits with latex-free products available at all times (II) (*32*).

VI. Sterilization and Disinfection of Patient-Care Items

A. General Recommendations

1. Use only FDA-cleared medical devices for sterilization and follow the manufacturer's instructions for correct use (IB) (*248*).
2. Clean and heat-sterilize critical dental instruments before each use (IA) (*2,137,243,244,246,249,407*).
3. Clean and heat-sterilize semicritical items before each use (IB) (*2,249,260,407*).
4. Allow packages to dry in the sterilizer before they are handled to avoid contamination (IB) (*247*).
5. Use of heat-stable semicritical alternatives is encouraged (IB) (*2*).
6. Reprocess heat-sensitive critical and semi-critical instruments by using FDA-cleared sterilant/high-level disinfectants or an FDA-cleared low-temperature sterilization method (e.g., ethylene oxide). Follow manufacturer's instructions for use of chemical sterilants/high-level disinfectants (IB) (*243*).
7. Single-use disposable instruments are acceptable alternatives if they are used only once and disposed of correctly (IB, IC) (*243,383*).
8. Do not use liquid chemical sterilants/high-level disinfectants for environmental surface disinfection or as holding solutions (IB, IC) (*243,245*).
9. Ensure that noncritical patient-care items are barrier-protected or cleaned, or if visibly soiled, cleaned and disinfected after each use with an EPA-registered hospital disinfectant. If visibly contaminated with blood, use an EPA-registered hospital disinfectant with a tuberculocidal claim (i.e., intermediate level) (IB) (*2,243,244*).
10. Inform DHCP of all OSHA guidelines for exposure to chemical agents used for disinfection and sterilization. Using this report, identify areas and tasks that have potential for exposure (IC) (*15*).

B. Instrument Processing Area

1. Designate a central processing area. Divide the instrument processing area, physically or, at a minimum, spatially, into distinct areas for 1) receiving, cleaning, and decontamination; 2) preparation and packaging; 3) sterilization; and 4) storage. Do not store instruments in an area where contaminated instruments are held or cleaned (II) (*173,247,248*).
2. Train DHCP to employ work practices that prevent contamination of clean areas (II).

C. Receiving, Cleaning, and Decontamination Work Area

1. Minimize handling of loose contaminated instruments during transport to the instrument processing area. Use work-practice controls (e.g., carry instruments in a covered container) to minimize exposure potential (II). Clean all visible blood and other contamination from dental instruments and devices before sterilization or disinfection procedures (IA) (*243,249–252*).
2. Use automated cleaning equipment (e.g., ultrasonic cleaner or washer-disinfector) to remove

debris to improve cleaning effectiveness and decrease worker exposure to blood (IB) (*2,253*).

3. Use work-practice controls that minimize contact with sharp instruments if manual cleaning is necessary (e.g., long-handled brush) (IC) (*14*).
4. Wear puncture- and chemical-resistant/heavy-duty utility gloves for instrument cleaning and decontamination procedures (IB) (*7*).
5. Wear appropriate PPE (e.g., mask, protective eyewear, and gown) when splashing or spraying is anticipated during cleaning (IC) (*13*).

D. **Preparation and Packaging**

1. Use an internal chemical indicator in each package. If the internal indicator cannot be seen from outside the package, also use an external indicator (II) (*243,254,257*).
2. Use a container system or wrapping compatible with the type of sterilization process used and that has received FDA clearance (IB) (*243,247, 256*).
3. Before sterilization of critical and semicritical instruments, inspect instruments for cleanliness, then wrap or place them in containers designed to maintain sterility during storage (e.g., cassettes and organizing trays) (IA) (*2,247,255,256*).

E. **Sterilization of Unwrapped Instruments**

1. Clean and dry instruments before the unwrapped sterilization cycle (IB) (*248*).
2. Use mechanical and chemical indicators for each unwrapped sterilization cycle (i.e., place an internal chemical indicator among the instruments or items to be sterilized) (IB) (*243,258*).
3. Allow unwrapped instruments to dry and cool in the sterilizer before they are handled to avoid contamination and thermal injury (II) (*260*).
4. Semicritical instruments that will be used immediately or within a short time can be sterilized unwrapped on a tray or in a container system, provided that the instruments are handled aseptically during removal from the sterilizer and transport to the point of use (II).
5. Critical instruments intended for immediate reuse can be sterilized unwrapped if the instruments are maintained sterile during removal from the sterilizer and transport to the point of use (e.g., transported in a sterile covered container) (IB) (*258*).
6. Do not sterilize implantable devices unwrapped (IB) (*243,247*).
7. Do not store critical instruments unwrapped (IB) (*248*).

F. **Sterilization Monitoring**

1. Use mechanical, chemical, and biological monitors according to the manufacturer's instructions to ensure the effectiveness of the sterilization process (IB) (*248,278,279*).
2. Monitor each load with mechanical (e.g., time, temperature, and pressure) and chemical indicators (II) (*243,248*).
3. Place a chemical indicator on the inside of each package. If the internal indicator is not visible from the outside, also place an exterior chemical indicator on the package (II) (*243,254,257*).
4. Place items/packages correctly and loosely into the sterilizer so as not to impede penetration of the sterilant (IB) (*243*).
5. Do not use instrument packs if mechanical or chemical indicators indicate inadequate processing (IB) (*243,247,248*).
6. Monitor sterilizers at least weekly by using a biological indicator with a matching control (i.e., biological indicator and control from same lot number) (IB) (*2,9,243,247,278,279*).
7. Use a biological indicator for every sterilizer load that contains an implantable device. Verify results before using the implantable device, whenever possible (IB) (*243,248*).
8. The following are recommended in the case of a positive spore test:
   a. Remove the sterilizer from service and review sterilization procedures (e.g., work practices and use of mechanical and chemical indicators) to determine whether operator error could be responsible (II) (*8*).
   b. Retest the sterilizer by using biological, mechanical, and chemical indicators after correcting any identified procedural problems (II).
   c. If the repeat spore test is negative, and mechanical and chemical indicators are within normal limits, put the sterilizer back in service (II) (*9,243*).
9. The following are recommended if the repeat spore test is positive:
   a. Do not use the sterilizer until it has been inspected or repaired or the exact reason for the positive test has been determined (II) (*9,243*).

b. Recall, to the extent possible, and reprocess all items processed since the last negative spore test (II) (*9,243,283*).

c. Before placing the sterilizer back in service, rechallenge the sterilizer with biological indicator tests in three consecutive empty chamber sterilization cycles after the cause of the sterilizer failure has been determined and corrected (II) (*9,243,283*).

10. Maintain sterilization records (i.e., mechanical, chemical, and biological) in compliance with state and local regulations (IB) (*243*).

G. **Storage Area for Sterilized Items and Clean Dental Supplies**

1. Implement practices on the basis of date- or event-related shelf-life for storage of wrapped, sterilized instruments and devices (IB) (*243, 284*).
2. Even for event-related packaging, at a minimum, place the date of sterilization, and if multiple sterilizers are used in the facility, the sterilizer used, on the outside of the packaging material to facilitate the retrieval of processed items in the event of a sterilization failure (IB) (*243,247*).
3. Examine wrapped packages of sterilized instruments before opening them to ensure the barrier wrap has not been compromised during storage (II) (*243,284*).
4. Reclean, repack, and resterilize any instrument package that has been compromised (II).
5. Store sterile items and dental supplies in covered or closed cabinets, if possible (II) (*285*).

VII. Environmental Infection Control

A. **General Recommendations**

1. Follow the manufacturers' instructions for correct use of cleaning and EPA-registered hospital disinfecting products (IB, IC) (*243–245*).
2. Do not use liquid chemical sterilants/high-level disinfectants for disinfection of environmental surfaces (clinical contact or housekeeping) (IB, IC) (*243–245*).
3. Use PPE, as appropriate, when cleaning and disinfecting environmental surfaces. Such equipment might include gloves (e.g., puncture- and chemical-resistant utility), protective clothing (e.g., gown, jacket, or lab coat), and protective eyewear/face shield, and mask (IC) (*13,15*).

B. **Clinical Contact Surfaces**

1. Use surface barriers to protect clinical contact surfaces, particularly those that are difficult to clean (e.g., switches on dental chairs) and change surface barriers between patients (II) (*1,2,260, 288*).
2. Clean and disinfect clinical contact surfaces that are not barrier-protected, by using an EPA-registered hospital disinfectant with a low- (i.e., HIV and HBV label claims) to intermediate-level (i.e., tuberculocidal claim) activity after each patient. Use an intermediate-level disinfectant if visibly contaminated with blood (IB) (*2,243,244*).

C. **Housekeeping Surfaces**

1. Clean housekeeping surfaces (e.g., floors, walls, and sinks) with a detergent and water or an EPA-registered hospital disinfectant/detergent on a routine basis, depending on the nature of the surface and type and degree of contamination, and as appropriate, based on the location in the facility, and when visibly soiled (IB) (*243,244*).
2. Clean mops and cloths after use and allow to dry before reuse; or use single-use, disposable mop heads or cloths (II) (*243,244*).
3. Prepare fresh cleaning or EPA-registered disinfecting solutions daily and as instructed by the manufacturer. (II) (*243,244*).
4. Clean walls, blinds, and window curtains in patient-care areas when they are visibly dusty or soiled (II) (*9,244*).

D. **Spills of Blood and Body Substances**

1. Clean spills of blood or OPIM and decontaminate surface with an EPA-registered hospital disinfectant with low- (i.e., HBV and HIV label claims) to intermediate-level (i.e., tuberculocidal claim) activity, depending on size of spill and surface porosity (IB, IC) (*13,113*).

E. **Carpet and Cloth Furnishings**

1. Avoid using carpeting and cloth-upholstered furnishings in dental operatories, laboratories, and instrument processing areas (II) (*9,293–295*).

F. **Regulated Medical Waste**

1. General Recommendations

a. Develop a medical waste management program. Disposal of regulated medical waste must follow federal, state, and local regulations (IC) (*13,301*).

b. Ensure that DHCP who handle and dispose of regulated medical waste are trained in appropriate handling and disposal methods

and informed of the possible health and safety hazards (IC) (*13*).

2. Management of Regulated Medical Waste in Dental Health-Care Facilities
   a. Use a color-coded or labeled container that prevents leakage (e.g., biohazard bag) to contain nonsharp regulated medical waste (IC) (*13*).
   b. Place sharp items (e.g., needles, scalpel blades, orthodontic bands, broken metal instruments, and burs) in an appropriate sharps container (e.g., puncture resistant, color-coded, and leakproof). Close container immediately before removal or replacement to prevent spillage or protrusion of contents during handling, storage, transport, or shipping (IC) (*2,8,13,113,115*).
   c. Pour blood, suctioned fluids or other liquid waste carefully into a drain connected to a sanitary sewer system, if local sewage discharge requirements are met and the state has declared this an acceptable method of disposal. Wear appropriate PPE while performing this task (IC) (*7,9,13*).

VIII. Dental Unit Waterlines, Biofilm, and Water Quality

A. General Recommendations

1. Use water that meets EPA regulatory standards for drinking water (i.e., ≤500 CFU/mL of heterotrophic water bacteria) for routine dental treatment output water (IB, IC) (*341,342*).
2. Consult with the dental unit manufacturer for appropriate methods and equipment to maintain the recommended quality of dental water (II) (*339*).
3. Follow recommendations for monitoring water quality provided by the manufacturer of the unit or waterline treatment product (II).
4. Discharge water and air for a minimum of 20–30 seconds after each patient, from any device connected to the dental water system that enters the patient's mouth (e.g., handpieces, ultrasonic scalers, and air/water syringes) (II) (*2,311,344*).
5. Consult with the dental unit manufacturer on the need for periodic maintenance of antiretraction mechanisms (IB) (*2,311*).

B. Boil-Water Advisories

1. The following apply while a boil-water advisory is in effect:
   a. Do not deliver water from the public water system to the patient through the dental operative unit, ultrasonic scaler, or other dental equipment that uses the public water system (IB, IC) (*341,342,346,349,350*).
   b. Do not use water from the public water system for dental treatment, patient rinsing, or handwashing (IB, IC) (*341,342,346,349, 350*).
   c. For handwashing, use antimicrobial-containing products that do not require water for use (e.g., alcohol-based hand rubs). If hands are visibly contaminated, use bottled water, if available, and soap for handwashing or an antiseptic towelette (IB, IC) (*13,122*).
2. The following apply when the boil-water advisory is cancelled:
   a. Follow guidance given by the local water utility regarding adequate flushing of waterlines. If no guidance is provided, flush dental waterlines and faucets for 1–5 minutes before using for patient care (IC) (*244,346, 351,352*).
   b. Disinfect dental waterlines as recommended by the dental unit manufacturer (II).

IX. Special Considerations

A. Dental Handpieces and Other Devices Attached to Air and Waterlines

1. Clean and heat-sterilize handpieces and other intraoral instruments that can be removed from the air and waterlines of dental units between patients (IB, IC) (*2,246,275,356,357,360,407*).
2. Follow the manufacturer's instructions for cleaning, lubrication, and sterilization of handpieces and other intraoral instruments that can be removed from the air and waterlines of dental units (IB) (*361–363*).
3. Do not surface-disinfect, use liquid chemical sterilants, or ethylene oxide on handpieces and other intraoral instruments that can be removed from the air and waterlines of dental units (IC) (*2,246,250,275*).
4. Do not advise patients to close their lips tightly around the tip of the saliva ejector to evacuate oral fluids (II) (*364–366*).

B. Dental Radiology

1. Wear gloves when exposing radiographs and handling contaminated film packets. Use other PPE (e.g., protective eyewear, mask, and gown) as appropriate if spattering of blood or other body fluids is likely (IA, IC) (*11,13*).

2. Use heat-tolerant or disposable intraoral devices whenever possible (e.g., film-holding and positioning devices). Clean and heat-sterilize heat-tolerant devices between patients. At a minimum, high-level disinfect semicritical heat-sensitive devices, according to manufacturer's instructions (IB) (*243*).
3. Transport and handle exposed radiographs in an aseptic manner to prevent contamination of developing equipment (II).
4. The following apply for digital radiography sensors:
   a. Use FDA-cleared barriers (IB) (*243*).
   b. Clean and heat-sterilize, or high-level disinfect, between patients, barrier-protected semicritical items. If the item cannot tolerate these procedures then, at a minimum, protect with an FDA-cleared barrier and clean and disinfect with an EPA-registered hospital disinfectant with intermediate-level (i.e., tuberculocidal claim) activity, between patients. Consult with the manufacturer for methods of disinfection and sterilization of digital radiology sensors and for protection of associated computer hardware (IB) (*243*).

C. **Aseptic Technique for Parenteral Medications**
1. Do not administer medication from a syringe to multiple patients, even if the needle on the syringe is changed (IA) (*378*).
2. Use single-dose vials for parenteral medications when possible (II) (*376,377*).
3. Do not combine the leftover contents of single-use vials for later use (IA) (*376,377*).
4. The following apply if multidose vials are used:
   a. Cleanse the access diaphragm with 70% alcohol before inserting a device into the vial (IA) (*380,381*).
   b. Use a sterile device to access a multiple-dose vial and avoid touching the access diaphragm. Both the needle and syringe used to access the multidose vial should be sterile. Do not reuse a syringe even if the needle is changed (IA) (*380,381*).
   c. Keep multidose vials away from the immediate patient treatment area to prevent inadvertent contamination by spray or spatter (II).
   d. Discard the multidose vial if sterility is compromised (IA) (*380,381*).
5. Use fluid infusion and administration sets (i.e., IV bags, tubings and connections) for one patient only and dispose of appropriately (IB) (*378*).

D. **Single-Use (Disposable) Devices**
1. Use single-use devices for one patient only and dispose of them appropriately (IC) (*383*).

E. **Preprocedural Mouth Rinses**
1. No recommendation is offered regarding use of preprocedural antimicrobial mouth rinses to prevent clinical infections among DHCP or patients. Although studies have demonstrated that a preprocedural antimicrobial rinse (e.g., chlorhexidine gluconate, essential oils, or povidone-iodine) can reduce the level of oral microorganisms in aerosols and spatter generated during routine dental procedures and can decrease the number of microorganisms introduced in the patient's bloodstream during invasive dental procedures (*391–399*), the scientific evidence is inconclusive that using these rinses prevents clinical infections among DHCP or patients (see discussion, Preprocedural Mouth Rinses) (Unresolved issue).

F. **Oral Surgical Procedures**
1. The following apply when performing oral surgical procedures:
   a. Perform surgical hand antisepsis by using an antimicrobial product (e.g., antimicrobial soap and water, or soap and water followed by alcohol-based hand scrub with persistent activity) before donning sterile surgeon's gloves (IB) (*127–132,137*).
   b. Use sterile surgeon's gloves (IB) (*2,7,121, 123,137*).
   c. Use sterile saline or sterile water as a coolant/irrigatant when performing oral surgical procedures. Use devices specifically designed for delivering sterile irrigating fluids (e.g., bulb syringe, single-use disposable products, and sterilizable tubing) (IB) (*2,121*).

G. **Handling of Biopsy Specimens**
1. During transport, place biopsy specimens in a sturdy, leakproof container labeled with the biohazard symbol (IC) (*2,13,14*).
2. If a biopsy specimen container is visibly contaminated, clean and disinfect the outside of a

container or place it in an impervious bag labeled with the biohazard symbol, (IC) (*2,13*).

H. **Handling of Extracted Teeth**

1. Dispose of extracted teeth as regulated medical waste unless returned to the patient (IC) (*13,14*).
2. Do not dispose of extracted teeth containing amalgam in regulated medical waste intended for incineration (II).
3. Clean and place extracted teeth in a leakproof container, labeled with a biohazard symbol, and maintain hydration for transport to educational institutions or a dental laboratory (IC) (*13,14*).
4. Heat-sterilize teeth that do not contain amalgam before they are used for educational purposes (IB) (*403,405,406*).

I. **Dental Laboratory**

1. Use PPE when handling items received in the laboratory until they have been decontaminated (IA, IC) (*2,7,11,13,113*).
2. Before they are handled in the laboratory, clean, disinfect, and rinse all dental prostheses and prosthodontic materials (e.g., impressions, bite registrations, occlusal rims, and extracted teeth) by using an EPA-registered hospital disinfectant having at least an intermediate-level (i.e., tuberculocidal claim) activity (IB) (*2,249,252,407*).
3. Consult with manufacturers regarding the stability of specific materials (e.g., impression materials) relative to disinfection procedures (II).
4. Include specific information regarding disinfection techniques used (e.g., solution used and duration), when laboratory cases are sent off-site and on their return (II) (*2,407,409*).
5. Clean and heat-sterilize heat-tolerant items used in the mouth (e.g., metal impression trays and face-bow forks) (IB) (*2,407*).
6. Follow manufacturers' instructions for cleaning and sterilizing or disinfecting items that become contaminated but do not normally contact the patient (e.g., burs, polishing points, rag wheels, articulators, case pans, and lathes). If manufacturer instructions are unavailable, clean and heat-sterilize heat-tolerant items or clean and disinfect with an EPA-registered hospital disinfectant with low- (HIV, HBV effectiveness claim) to intermediate-level (tuberculocidal claim) activity, depending on the degree of contamination (II).

J. **Laser/Electrosurgery Plumes/Surgical Smoke**

1. No recommendation is offered regarding practices to reduce DHCP exposure to laser plumes/surgical smoke when using lasers in dental practice. Practices to reduce HCP exposure to laser plumes/surgical smoke have been suggested, including use of a) standard precautions (e.g., high-filtration surgical masks and possibly full face shields) (*437*); b) central room suction units with in-line filters to collect particulate matter from minimal plumes; and c) dedicated mechanical smoke exhaust systems with a high-efficiency filter to remove substantial amounts of laser-plume particles. The effect of the exposure (e.g., disease transmission or adverse respiratory effects) on DHCP from dental applications of lasers has not been adequately evaluated (see previous discussion, Laser/Electrosurgery Plumes or Surgical Smoke) (Unresolved issue).

K. ***Mycobacterium tuberculosis***

1. General Recommendations
   a. Educate all DHCP regarding the recognition of signs, symptoms, and transmission of TB (IB) (*20,21*).
   b. Conduct a baseline TST, preferably by using a two-step test, for all DHCP who might have contact with persons with suspected or confirmed active TB, regardless of the risk classification of the setting (IB) (*20*).
   c. Assess each patient for a history of TB as well as symptoms indicative of TB and document on the medical history form (IB) (*20,21*).
   d. Follow CDC recommendations for 1) developing, maintaining, and implementing a written TB infection-control plan; 2) managing a patient with suspected or active TB; 3) completing a community risk-assessment to guide employee TSTs and follow-up; and 4) managing DHCP with TB disease (IB) (*2,21*).
2. The following apply for patients known or suspected to have active TB:
   a. Evaluate the patient away from other patients and DHCP. When not being evaluated, the patient should wear a surgical mask or be instructed to cover mouth and nose when coughing or sneezing (IB) (*20,21*).
   b. Defer elective dental treatment until the patient is noninfectious (IB) (*20,21*).

c. Refer patients requiring urgent dental treatment to a previously identified facility with TB engineering controls and a respiratory protection program (IB) (*20,21*).

L. Creutzfeldt-Jakob Disease (CJD) and Other Prion Diseases

1. No recommendation is offered regarding use of special precautions in addition to standard precautions when treating known CJD or vCJD patients. Potential infectivity of oral tissues in CJD or vCJD patients is an unresolved issue. Scientific data indicate the risk, if any, of sporadic CJD transmission during dental and oral surgical procedures is low to nil. Until additional information exists regarding the transmissibility of CJD or vCJD during dental procedures, special precautions in addition to standard precautions might be indicated when treating known CJD or vCJD patients; a list of such precautions is provided for consideration without recommendation (see Creutzfeldt-Jakob Disease and Other Prion Diseases) (Unresolved issue).

M. Program Evaluation

1. Establish routine evaluation of the infection-control program, including evaluation of performance indicators, at an established frequency (II) (*470-471*).

Infection-Control Internet Resources

Advisory Committee on Immunization Practices
http://www.cdc.gov/nip/ACIP/default.htm
American Dental Association
http://www.ada.org
American Institute of Architects Academy of Architecture for Health
http://www.aahaia.org
American Society of Heating, Refrigeration, Air-conditioning Engineers
http://www.ashrae.org
Association for Professionals in Infection Control and Epidemiology, Inc.
http://www.apic.org/resc/guidlist.cfm
CDC, Division of Healthcare Quality Promotion
http://www.cdc.gov/ncidod/hip
CDC, Division of Oral Health, Infection Control
http://www.cdc.gov/OralHealth/infectioncontrol/index.htm
CDC, *Morbidity and Mortality Weekly Report*
http://www.cdc.gov/mmwr
CDC, NIOSH
http://www.cdc.gov/niosh/homepage.html
CDC Recommends, Prevention Guidelines System
http://www.phppo.cdc.gov/cdcRecommends/AdvSearchV.asp
EPA, Antimicrobial Chemicals
http://www.epa.gov/oppad001/chemregindex.htm
FDA
http://www.fda.gov
Immunization Action Coalition
http://www.immunize.org/acip
Infectious Diseases Society of America
http://www.idsociety.org/PG/toc.htm
OSHA, Dentistry, Bloodborne Pathogens
http://www.osha.gov/SLTC/dentistry/index.html
http://www.osha.gov/SLTC/bloodbornepathogens/index.html
Organization for Safety and Asepsis Procedures
http://www.osap.org
Society for Healthcare Epidemiology of America, Inc., Position Papers
http://www.shea-online.org/PositionPapers.html

Acknowledgement

The Division of Oral Health thanks the working group as well as CDC and other federal and external reviewers for their efforts in developing and reviewing drafts of this report and acknowledges that all opinions of the reviewers might not be reflected in all of the recommendations.

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Appendix A

Regulatory Framework for Disinfectants and Sterilants

When using the guidance provided in this report regarding use of liquid chemical disinfectants and sterilants, dental health-care personnel (DHCP) should be aware of federal laws and regulations that govern the sale, distribution, and use of these products. In particular, DHCPs should know what requirements pertain to them when such products are used. Finally, DHCP should understand the relative roles of the U.S. Environmental Protection Agency (EPA), the U.S. Food and Drug Administration (FDA), the Occupational Safety and Health Administration (OSHA) and CDC.

The choice of specific cleaning or disinfecting agents is largely a matter of judgment, guided by product label claims and instructions and government regulations. A single liquid chemical germicide might not satisfy all disinfection requirements in a given dental practice or facility. Realistic use of liquid chemical germicides depends on consideration of multiple factors, including the degree of microbial killing required; the nature and composition of the surface, item, or device to be treated; and the cost, safety, and ease of use of the available agents. Selecting one appropriate product with a higher degree of potency to cover all situations might be more convenient.

In the United States, liquid chemical germicides (disinfectants) are regulated by EPA and FDA (*A-1–A-3*). In health-care settings, EPA regulates disinfectants that are used on environmental surfaces (housekeeping and clinical contact surfaces), and FDA regulates liquid chemical sterilants/high-level disinfectants (e.g., glutaraldehyde, hydrogen peroxide, and peracetic acid) used on critical and semicritical patient-care devices. Disinfectants intended for use on clinical contact surfaces (e.g., light handles, radiographic-ray heads, or drawer knobs) or housekeeping surfaces (e.g., floors, walls, or sinks) are regulated in interstate commerce by the Antimicrobials Division, Office of Pesticide Programs, EPA, under the authority of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) of 1947, as amended in 1996 (*A-4*). Under FIFRA, any substance or mixture of substances intended to prevent, destroy, repel, or mitigate any pest, including microorganisms but excluding those in or on living man or animals, must be registered before sale or distribution. To obtain a registration, a manufacturer must submit specific data regarding the safety and the effectiveness of each product.

EPA requires manufacturers to test formulations by using accepted methods for microbicidal activity, stability, and toxicity to animals and humans. Manufacturers submit these data to EPA with proposed labeling. If EPA concludes a product may be used without causing unreasonable adverse effects, the product and its labeling are given an EPA registration number, and the manufacturer may then sell and distribute the product in the United States. FIFRA requires users of products to follow the labeling directions on each product explicitly. The following statement appears on all EPA-registered product labels under the Directions for Use heading: "It is a violation of federal law to use this product inconsistent with its labeling." This means that DHCP must follow the safety precautions and use directions on the labeling of each registered product. Not following the specified dilution, contact time, method of application, or any other condition of use is considered misuse of the product.

FDA, under the authority of the 1976 Medical Devices Amendment to the Food, Drug, and Cosmetic Act, regulates chemical germicides if they are advertised and marketed for use on specific medical devices (e.g., dental unit waterline or flexible endoscope). A liquid chemical germicide marketed for use on a specific device is considered, for regulatory purposes, a medical device itself when used to disinfect that specific medical device. Also, this FDA regulatory authority over a particular instrument or device dictates that the manufacturer is obligated to provide the user with adequate instructions for the safe and effective use of that device. These instructions must include methods to clean and disinfect or sterilize the item if it is to be marketed as a reusable medical device.

OSHA develops workplace standards to help ensure safe and healthful working conditions in places of employment. OSHA is authorized under Pub. L. 95-251, and as amended, to enforce these workplace standards. In 1991, OSHA published Occupational Exposure to Bloodborne Pathogens; final rule [29 CFR Part 1910.1030] (*A-5*). This standard is designed to help prevent occupational exposures to blood or other potentially infectious substances. Under this standard, OSHA has interpreted that, to decontaminate contaminated work surfaces, either an EPA-registered hospital tuberculocidal disinfectant or an EPA-registered hospital disinfectant labeled as effective against human immunodeficiency virus (HIV) and hepatitis B virus (HBV) is appropriate. Hospital disinfectants with such HIV and HBV claims can be used, provided surfaces are not contaminated with agents or concentration of agents for which higher level (i.e., intermediate-level) disinfection is recommended. In addition, as with all disinfectants, effectiveness is governed by strict adherence to the label instructions for intended use of the product.

CDC is not a regulatory agency and does not test, evaluate, or otherwise recommend specific brand-name products of chemical germicides. This report is intended to provide overall guidance for providers to select general classifications of products based on certain infection-control principles. In this report, CDC provides guidance to practitioners regarding appropriate application of EPA- and FDA-registered liquid chemical disinfectants and sterilants in dental health-care settings.

CDC recommends disinfecting environmental surfaces or sterilizing or disinfecting medical equipment, and DHCP should use products approved by EPA and FDA unless no such products are available for use against certain microorganisms or sites. However, if no registered or approved products are available for a specific pathogen or use situation, DHCP are advised to follow the specific guidance regarding unregistered or unapproved (e.g., off-label) uses for various chemical germicides. For example, no antimicrobial products are registered for use specifically against certain emerging pathogens (e.g., Norwalk virus), potential terrorism agents (e.g., variola major or *Yersinia pestis*), or Creutzfeldt-Jakob disease agents.

One point of clarification is the difference in how EPA and FDA classify disinfectants. FDA adopted the same basic terminology and classification scheme as CDC to categorize medical devices (i.e., critical, semicritical, and noncritical) and to define antimicrobial potency for processing surfaces (i.e., sterilization, and high-, intermediate- and low-level disinfection) (*A-6*). EPA registers environmental surface disinfectants based on the manufacturer's microbiological activity claims when registering its disinfectant. This difference has led to confusion on the part of users because the EPA does not use the terms intermediate- and low-level disinfectants as used in CDC guidelines.

CDC designates any EPA-registered hospital disinfectant without a tuberculocidal claim as a low-level disinfectant and any EPA-registered hospital disinfectant with a tuberculocidal claim as an intermediate-level disinfectant. To understand this comparison, one needs to know how EPA registers disinfectants. First, to be labeled as an EPA hospital disinfectant, the product must pass Association of Official Analytical Chemists (AOAC) effectiveness tests against three target organisms: *Salmonella choleraesuis* for effectiveness against gram-negative bacteria; *Staphylococcus aureus* for effectiveness against gram-positive bacteria; and *Pseudomonas aeruginosa* for effectiveness against a primarily nosocomial pathogen. Substantiated label claims of effectiveness of a disinfectant against specific microorganisms other than the test microorganisms are permitted, but not required, provided that the test microorganisms are likely to be present in or on the recommended use areas and surfaces. Therefore, manufacturers might also test specifically against organisms of known concern in health-care practices (e.g., HIV, HBV, hepatitis C virus [HCV], and herpes) although it is considered likely that any product satisfying AOAC tests for hospital disinfectant designation will also be effective against these relatively fragile organisms when the product is used as directed by the manufacturer.

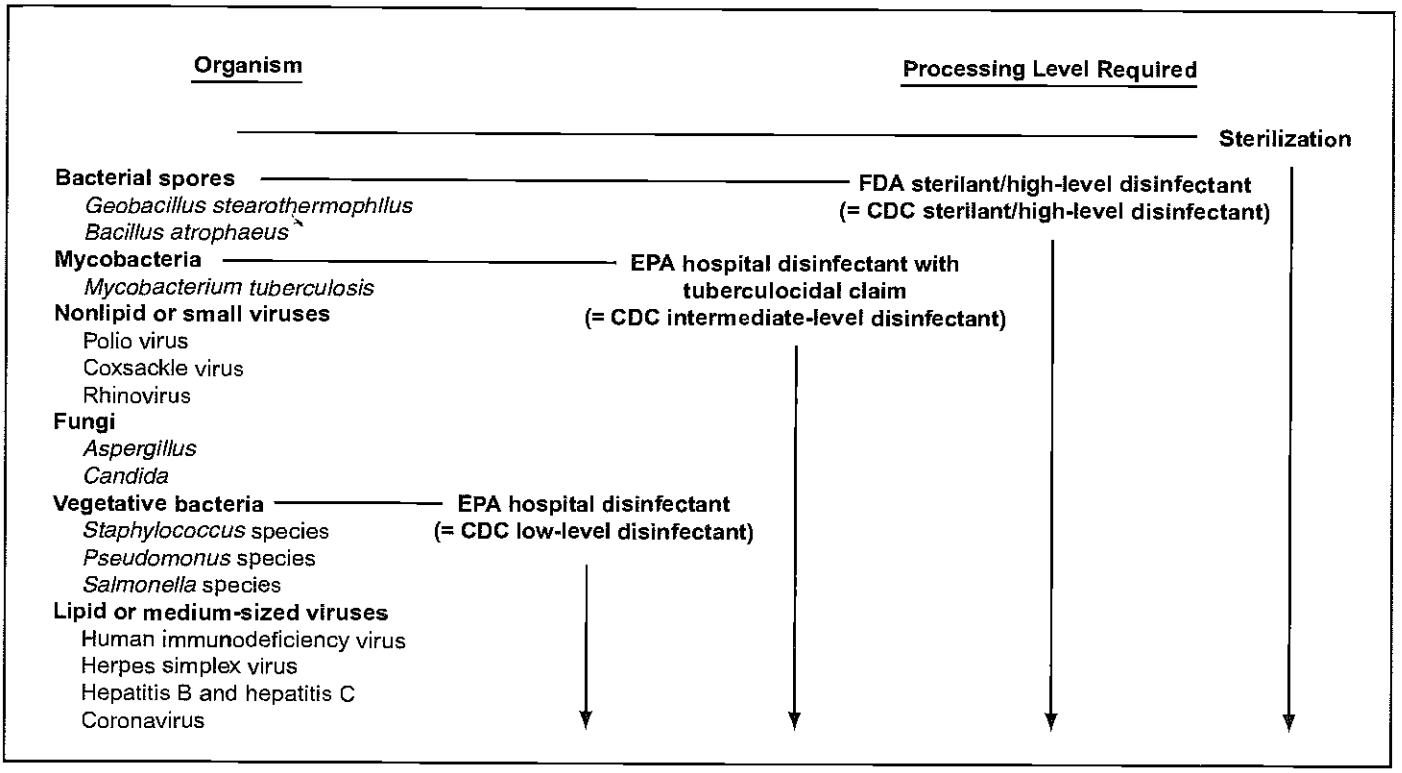
Potency against *Mycobacterium tuberculosis* has been recognized as a substantial benchmark. However, the tuberculocidal claim is used only as a benchmark to measure germicidal potency. Tuberculosis is not transmitted via environmental surfaces but rather by the airborne route. Accordingly, use of such products on environmental surfaces plays no role in preventing the spread of tuberculosis. However, because mycobacteria have among the highest intrinsic levels of resistance among the vegetative bacteria, viruses, and fungi, any germicide with a tuberculocidal claim on the label is considered capable of inactivating a broad spectrum of pathogens, including such less-resistant organisms as bloodborne pathogens (e.g., HBV, HCV, and HIV). It is this broad-spectrum capability, rather than the product's specific potency against mycobacteria, that is the basis for protocols and regulations dictating use of tuberculocidal chemicals for surface disinfection.

EPA also lists disinfectant products according to their labeled use against these organisms of interest as follows:

- **List B**. Tuberculocide products effective against *Mycobacterium* species.
- **List C**. Products effective against human HIV-1 virus.
- **List D**. Products effective against human HIV-1 virus and HBV.
- **List E**. Products effective against *Mycobacterium* species, human HIV-1 virus, and HBV.
- **List F**. Products effective against HCV.

Microorganisms vary in their resistance to disinfection and sterilization, enabling CDC's designation of disinfectants as high-, intermediate-, and low-level, when compared with EPA's designated organism spectrum (Figure). However, exceptions to this general guide exist, and manufacturer's label claims and instructions should always be followed.

FIGURE. Decreasing order of resistance of microorganisms to germicidal chemicals



Source: Adapted from Bond WW, Ott BJ, Franke K, McCracken JE. Effective use of liquid chemical germicides on medical devices; instrument design problems. In: Block SS, ed. Disinfection, sterilization and preservation. 4th ed. Philadelphia, PA: Lea & Gebiger, 1991:1100.

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Appendix B

Immunizations Strongly Recommended for Health-Care Personnel (HCP)

Vaccine	Dose schedule	Indications	Major precautions and contraindications	Special considerations
Hepatitis B recombinant vaccine*	Three-dose schedule administered intramuscularly (IM) in the deltoid; 0,1,6 - second dose administered 1 month after first dose; third dose administered 4 months after second. Booster doses are not necessary for persons who have developed adequate antibodies to hepatitis B surface antigen (anti-HBs).	Health-care personnel (HCP) at risk for exposure to blood and body fluids.	History of anaphylactic reaction to common baker's yeast. Pregnancy is not a contraindication.	No therapeutic or adverse effects on hepatitis B virus (HBV)-infected persons; cost-effectiveness of prevaccination screening for susceptibility to HBV depends on costs of vaccination and antibody testing and prevalence of immunity in the group of potential vaccinees; health-care personnel who have ongoing contact with patients or blood should be tested 1–2 months after completing the vaccination series to determine serologic response. If vaccination does not induce adequate anti-HBs (>10 mIU/mL), a second vaccine series should be administered.
Influenza vaccine (inactivated)¶	Annual single-dose vaccination IM with current vaccine.	HCP who have contact with patients at high risk or who work in chronic-care facilities; HCP aged ≥50 years or who have high-risk medical conditions.	History of anaphylactic hypersensitivity to eggs or to other components of the vaccine.	Recommended for women who will be in the second or third trimesters of pregnancy during the influenza season and women in any stage of pregnancy who have chronic medical conditions that are associated with an increased risk of influenza.§
Measles live-virus vaccine	One dose administered subcutaneously (SC); second dose ≥4 weeks later.	HCP who were born during or after 1957 without documentation of 1) receipt of 2 doses of live vaccine on or after their first birthday, 2) physician-diagnosed measles, or 3) laboratory evidence of immunity. Vaccine should also be considered for all HCP who have no proof of immunity, including those born before 1957.	Pregnancy; immunocompromised† state (including human immunodeficiency virus [HIV]-infected persons with severe immunosuppression); history of anaphylactic reactions after gelatin ingestion or receipt of neomycin; or recent receipt of antibody-containing blood products.	Measles, mumps, rubella (MMR) is the recommended vaccine, if recipients are also likely to be susceptible to rubella or mumps; persons vaccinated during 1963–1967 with 1) measles killed-virus vaccine alone, 2) killed-virus vaccine followed by live-virus vaccine, or 3) a vaccine of unknown type, should be revaccinated with two doses of live-virus measles vaccine.
Mumps live-virus vaccine	One dose SC; no booster.	HCP believed susceptible can be vaccinated; adults born before 1957 can be considered immune.	Pregnancy; immunocompromised† state; history of anaphylactic reaction after gelatin ingestion or receipt of neomycin.	MMR is the recommended vaccine.
Rubella live-virus vaccine	One dose SC; no booster.	HCP, both male and female, who lack documentation of receipt of live vaccine on or after their first birthday, or lack of laboratory evidence of immunity can be vaccinated. Adults born before 1957 can be considered immune, except women of childbearing age.	Pregnancy; immunocompromised† state; history of anaphylactic reaction after receipt of neomycin.	Women pregnant when vaccinated or who become pregnant within 4 weeks of vaccination should be counseled regarding theoretic risks to the fetus; however, the risk of rubella vaccine-associated malformations among these women is negligible. MMR is the recommended vaccine.
Varicella-zoster live-virus vaccine	Two 0.5 mL doses SC 4–8 weeks apart if aged ≥13 years.	HCP without reliable history of varicella or laboratory evidence of varicella immunity.	Pregnancy; immunocompromised† state; history of anaphylactic reaction after receipt of neomycin or gelatin; recent receipt of antibody-containing blood products; salicylate use should be avoided for 6 weeks after vaccination.	Because 71%–93% of U.S.-born persons without a history of varicella are immune, serologic testing before vaccination might be cost-effective.

Sources: Adapted from Bolyard EA, Hospital Infection Control Practices Advisory Committee. Guidelines for infection control in health care personnel, 1998. Am J Infect Control 1998;26:289–354.
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* A federal standard issued in December 1991 under the Occupational Safety and Health Act mandates that hepatitis B vaccine be made available at the employer's expense to all HCP occupationally exposed to blood or other potentially infectious materials. The Occupational Safety and Health Administration requires that employers make available hepatitis B vaccinations, evaluations, and follow-up procedures in accordance with current CDC recommendations.

† Persons immunocompromised because of immune deficiencies, HIV infection, leukemia, lymphoma, generalized malignancy; or persons receiving immunosuppressive therapy with corticosteroids, alkylating drugs, antimetabolites; or persons receiving radiation.

§ Vaccination of pregnant women after the first trimester might be preferred to avoid coincidental association with spontaneous abortions, which are most common during the first trimester. However, no adverse fetal effects have been associated with influenza vaccination.

¶ A live attenuated influenza vaccine (LAIV) is FDA-approved for healthy persons aged 5-49 years. Because of the possibility of transmission of vaccine viruses from recipients of LAIV to other persons and in the absence of data on the risk of illness and among immunocompromised persons infected with LAIV viruses, the inactivated influenza vaccine is preferred for HCP who have close contact with immunocompromised persons.

Appendix C

Methods for Sterilizing and Disinfecting Patient-Care Items and Environmental Surfaces*

Process	Result	Method	Examples	Health-care application: Type of patient-care item	Health-care application: Environmental surfaces
Sterilization	Destroys all microorganisms, including bacterial spores.	Heat-automated			Not applicable
		High temperature	Steam, dry heat, unsaturated chemical vapor	Heat-tolerant critical and semicritical	
		Low temperature	Ethylene oxide gas, plasma sterilization	Heat-sensitive critical and semicritical	
		Liquid immersion†	**Chemical sterilants.** Glutaraldehyde, glutaraldehydes with phenol, hydrogen peroxide, hydrogen peroxide with peracetic acid. peracetic acid	Heat-sensitive critical and semicritical	
High-level disinfection	Destroys all microorganisms, but not necessarily high numbers of bacterial spores.	Heat-automated	Washer-disinfector	Heat-sensitive semicritical	Not applicable
		Liquid immersion†	**Chemical sterilants/high-level disinfectants.** Glutaraldehyde, glutaraldehyde with phenol, hydrogen peroxide, hydrogen peroxide with peracetic acid, ortho-phthalaldehyde		
Intermediate-level disinfection	Destroys vegetative bacteria and the majority of fungi and viruses. Inactivates *Mycobacterium bovis*.§ Not necessarily capable of killing bacterial spores.	Liquid contact	U.S. Environmental Protection Agency (EPA)-registered hospital disinfectant with label claim of tuberculocidal activity (e.g., chlorine-containing products, quaternary ammonium compounds with alcohol, phenolics, iodophors, EPA-registered chlorine-based product¶)	Noncritical with visible blood	Clinical contact surfaces; blood spills on housekeeping surfaces
Low-level disinfection	Destroys the majority of vegetative bacteria, certain fungi, and viruses. Does not inactivate *Mycobacterium bovis*.§	Liquid contact	EPA-registered hospital disinfectant with no label claim regarding tuberculocidal activity.** The Occupational Safety and Health Administration also requires label claims of human immunodeficiency virus (HIV) and hepatitis B virus (HBV) potency for clinical contact surfaces (e.g., quaternary ammonium compounds, some phenolics, some iodophors)	Noncritical without visible blood	Clinical contact surfaces; housekeeping surfaces

* EPA and the Food and Drug Administration (FDA) regulate chemical germicides used in health-care settings. FDA regulates chemical sterilants used on critical and semicritical medical devices, and the EPA regulates gaseous sterilants and liquid chemical disinfectants used on noncritical surfaces. FDA also regulates medical devices, including sterilizers. More information is available at 1) http://www.epa.gov/oppad001/chemregindex.htm, 2) http://www.fda.gov/cdrh/index.html, and 3) http://www.fda.gov/cdrh/ode/germlab.html.

† Contact time is the single critical variable distinguishing the sterilization process from high-level disinfection with FDA-cleared liquid chemical sterilants. FDA defines a high-level disinfectant as a sterilant used under the same contact conditions as sterilization except for a shorter immersion time (*C-1*).

§ The tuberculocidal claim is used as a benchmark to measure germicidal potency. Tuberculosis (TB) is transmitted via the airborne route rather than by environmental surfaces and, accordingly, use of such products on environmental surfaces plays no role in preventing the spread of TB. Because mycobacteria have among the highest intrinsic levels of resistance among vegetative bacteria, viruses, and fungi, any germicide with a tuberculocidal claim on the label (i.e., an intermediate-level disinfectant) is considered capable of inactivating a broad spectrum of pathogens, including much less resistant organisms, including bloodborne pathogens (e.g., HBV, hepatitis C virus [HCV], and HIV). It is this broad-spectrum capability, rather than the product's specific potency against mycobacteria, that is the basis for protocols and regulations dictating use of tuberculocidal chemicals for surface disinfection.

¶ Chlorine-based products that are EPA-registered as intermediate-level disinfectants are available commercially. In the absence of an EPA-registered chlorine-based product, a fresh solution of sodium hypochlorite (e.g., household bleach) is an inexpensive and effective intermediate-level germicide. Concentrations ranging from 500 ppm to 800 ppm of chlorine (1:100 dilution of 5.25% bleach and tap water, or approximately ¼ cup of 5.25% bleach to 1 gallon of water) are effective on environmental surfaces that have been cleaned of visible contamination. Appropriate personal protective equipment (e.g., gloves and goggles) should be worn when preparing hypochlorite solutions (*C-2,C-3*). Caution should be exercised, because chlorine solutions are corrosive to metals, especially aluminum.

** Germicides labeled as "hospital disinfectant" without a tuberculocidal claim pass potency tests for activity against three representative microorganisms: *Pseudomonas aeruginosa, Staphylococcus aureus,* and *Salmonella choleraesuis.*

References

C-1. Food and Drug Administration. Guidance for industry and FDA reviewers: content and format of premarket notification [510(k)] submissions for liquid chemical sterilants/high level disinfectants. Rockville, MD: US Department of Health and Human Services, Food and Drug Administration, 2000. Available at http://www.fda.gov/cdrh/ode/397.pdf.

C-2. US Department of Labor, Occupational Safety and Health Administration. 29 CFR Part 1910.1030. Occupational exposure to bloodborne pathogens; needlesticks and other sharps injuries; final rule. Federal Register 2001;66:5317–25. As amended from and includes 29 CFR Part 1910.1030. Occupational exposure to bloodborne pathogens; final rule. Federal Register 1991;56:64174–82. Available at http://www.osha.gov/SLTC/dentistry/index.html.

C-3. CDC. Guidelines for environmental infection control in health-care facilities: recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC). MMWR 2003;52(No. RR-10).

CDC

MMWR™

Morbidity and Mortality Weekly Report

Recommendations and Reports December 19, 2003 / Vol. 52 / No. RR-17

Continuing Education Activity Sponsored by CDC
Guidelines for Infection Control in Dental Health-Care Settings — 2003

EXPIRATION — December 19, 2006

You must complete and retutn the response form electronically or by mail by **December 19, 2006**, to receive continuing education credit. If you answer all of the questions, you will receive an award letter for 2.0 hours Continuing Medical Education (CME) credit; 0.2 Continuing Education Units (CEUs); or 2.2 contact hours Continuing Nursing Education (CNE) credit. If you return the form electronically, you will receive educational credit immediately. If you mail the form, you will receive educational credit in approximately 30 days. No fees are charged for participating in this continuing education activity.

INSTRUCTIONS

By Internet

1. Read this *MMWR* (Vol. 52, RR-17), which contains the correct answers to the questions beginning on the next page.
2. Go to the *MMWR* Continuing Education Internet site at <http://www.cdc.gov/mmwr/cme/conted.html>.
3. Select which exam you want to take and select whether you want to register for CME, CEU, or CNE credit.
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6. Submit your answers no later than **December 19, 2006**.
7. Immediately print your Certificate of Completion for your records.

By Mail or Fax

1. Read this *MMWR* (Vol. 52, RR-17), which contains the correct answers to the questions beginning on the next page.
2. Complete all registration information on the response form, including your name, mailing address, phone number, and e-mail address, if available.
3. Indicate whether you are registering for CME, CEU, or CNE credit.
4. Select your answers to the questions, and mark the corresponding letters on the response form. To receive continuing education credit, you must answer all of the questions. Questions with more than one correct answer will instruct you to "Indicate all that apply."
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   Centers for Disease Control and Prevention
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Goal and Objectives

This *MMWR* provides recommendations regarding infection control practices for dentistry settings. These recommendations were prepared by CDC staff after consultation with staff from other federal agencies and specialists in dental infection control. The goal of this report is to minimize the risk of disease transmission in dental health-care settings through improved understanding and practice of evidence-based infection control strategies. Upon completion of this continuing education activity, the reader should be able to 1) list the major components of a personnel health infection-control program in the dental setting; 2) list key measures for preventing transmission of bloodborne pathogens; 3) describe key elements of instrument processing and sterilization; 4) describe dental water quality concepts; and 5) demonstrate the importance of developing an infection-control program evaluation.

To receive continuing education credit, please answer all of the following questions.

1. **The components of a personnel health infection control program in a dental setting should include which of the following?**
   A. Infection control education and training for dental staff.
   B. Appropriate immunizations against vaccine-preventable diseases.
   C. Exposure prevention and postexposute management strategies.
   D. Policies regarding work-related illness and work restrictions.
   E. Confidentiality of work-related medical evaluations for dental staff.
   F. All of the above.

2. **Which of the following is true regarding standard infection-control precautions?**
   A. Standard precautions are strategies used to reduce the risk of transmission of pathogens in the health-care setting.
   B. Standard precautions should be used in caring for all patients, regardless of their infectious status.
   C. Expanded or transmission-based precautions are used beyond standard precautions to interrupt the spread of certain pathogens.
   D. Standard precautions apply to exposure to blood, all body fluids and secretions (except sweat), nonintact skin, and mucous membranes.
   E. All of the above.
   F. None of the above.

3. **Factors to consider in assessing need for follow-up after an occupational blood or body fluid exposure include . . .**
   A. the type of exposure.
   B. the type of body fluid.
   C. the bloodborne pathogen infection status of the source.
   D. the susceptibility of the exposed person.
   E. all of the above.
   F. none of the above.

4. **Which of the following is not usually worn as personal protective equipment when anticipating spatter of blood or body fluids?**
   A. Jacket with long sleeves.
   B. Gloves.
   C. Head covering.
   D. Protective eyewear or face shield.
   E. Face mask.

5. **Which of the following is not true regarding gloves?**
   A. Certain hand lotions can affect the integrity of gloves.
   B. Wearing gloves replaces the need for handwashing.
   C. Sterile surgical gloves are recommended for oral surgical procedures.
   D. The Food and Drug Administration (FDA) has identified glove failure rates for manufacturers.
   E. Certain glove materials can interfere with the setting of impression materials.

6. **Which of the following statements regarding processing of contaminated instruments is true?**
   A. Instruments should be processed in an area separate from where clean instruments are stored.
   B. Personnel should wear heavy-duty utility gloves.
   C. Instruments only need cleaning if they have visible contamination.
   D. Instruments should be heat-sterilized unless they are heat-sensitive.
   E. Cleaning an instrument precedes all sterilization and disinfection processes.
   F. A, B, D, and E are correct.

7. **Which of the following statements is true regarding monitoring the correct functioning of a sterilizer?**
   A. A chemical indicator should be placed in a visible area of the package before sterilization processing.
   B. A biological indicator spore test should be processed through a sterilizer cycle at least once a week.
   C. A biological indicator conttol test matching the same lot of the spore test should be submitted with the sterilizer spore test.
   D. Mechanical assessments of sterilizer cycle time and temperature should be monitored.
   E. All of the above.

8. **Low- to intermediate–level disinfectants used to clean environmental surfaces . . . (*Indicate all that apply.*)**
   A. rapidly inactivate human immunodeficiency virus and hepatitis B virus on clinical contact and housekeeping surfaces.
   B. must be FDA-registered.
   C. are used after prompt removal of blood or body substance contamination on a surface.
   D. are appropriate to disinfect floors, depending on type of contamination.
   E. all of the above.
   F. A, C, and D are correct.

9. **Which of the following statements is true regarding dental unit waterlines?**
   A. If municipal water is the source that enters the dental unit waterline, output will always meet drinking water quality.
   B. Flushing the waterlines for ≥2 minutes at the beginning of the day reduces the biofilm in the waterlines.
   C. Dentists should consult with the manufacturer of the dental unit or water delivery system to determine the best method for maintaining optimal water quality.
   D. Dental unit waterlines can reliably deliver optimal water quality when used for irrigation during a sutgical procedure.
   E. All of the above.
   F. A, B, and D are correct.

10. **Which of the following is true regarding a dental clinic infection control program evaluation?**
    A. A method to ensure a safe working environment should be in place to reduce the risk of health-care–associated infections among patients and occupational exposures among dental health-care personnel.
    B. Evaluation of a program should include documenting periodic observational assessments, reviewing completed checklists, and reviewing occupational exposures.
    C. An evaluation program does not improve an infection control program.
    D. A and B are correct.
    E. A and C are correct.
    F. All of the above.

11. **Indicate your work setting.**
    A. Private dental practice.
    B. Hospital dental setting.
    C. Academic institution.
    D. Laboratory.
    E. Other public health setting.
    F. Other.

12. Which best describes your professional activities?

A. Dentist.
B. Dental hygienist.
C. Dental laboratory staff.
D. Dental office staff.
E. Other medical profession.

13. I plan to use these recommendations as the basis for . . . (*Indicate all that apply.*)

A. health education materials.
B. insurance reimbursement policies.
C. local practice guidelines.
D. public policy.
E. other.

14. Each month, approximately how many dental patients do you treat?

A. None.
B. 1–10.
C. 11–50.
D. 51–100.
E. 101–200.
F. >200.

15. How much time did you spend reading this report and completing the exam?

A. <2.0 hours.
B. >2.0 hours but <3.0 hours.
C. >3.0 hours but <4.0.
D. >4.0 hours.

16. After reading this report, I am confident I can list the major components of a personnel health infection control program in the dental setting.

A. Strongly agree.
B. Agree.
C. Neither agree nor disagree.
D. Disagree.
E. Strongly disagree.

17. After reading this report, I am confident I can list key measures for preventing transmission of bloodborne pathogens.

A. Strongly agree.
B. Agree.
C. Neither agree nor disagree.
D. Disagree.
E. Strongly disagree.

18. After reading this report, I am confident I can describe key elements of instrument processing and sterilization.

A. Strongly agree.
B. Agree.
C. Neither agree nor disagree.
D. Disagree.
E. Strongly disagree.

19. After reading this report, I am confident I can describe dental water quality concepts.

A. Strongly agree.
B. Agree.
C. Neither agree nor disagree.
D. Disagree.
E. Strongly disagree.

20. After reading this report, I am confident I can demonstrate the importance of developing an infection-control program evaluation.

A. Strongly agree.
B. Agree.
C. Neither agree nor disagree.
D. Disagree.
E. Strongly disagree.

21. The objectives are relevant to the goal of this report.

A. Strongly agree.
B. Agree.
C. Neither agree nor disagree.
D. Disagree.
E. Strongly disagree.

(Continued on pg CE-4)

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MMWR Response Form for Continuing Education Credit
December 19, 2003/Vol. 52/No. RR-17
Guidelines for Infection Control in Dental Health-Care Settings — 2003

To receive continuing education credit, you must
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2. indicate your choice of CME, CEU, or CNE credit;
3. answer all of the test questions;
4. sign and date this form or a photocopy;
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Check One
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Last Name *First Name*

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Fill in the appropriate blocks to indicate your answers. Remember, you must answer all of the questions to receive continuing education credit!

1. [ ]A [ ]B [ ]C [ ]D [ ]E [ ]F
2. [ ]A [ ]B [ ]C [ ]D [ ]E [ ]F
3. [ ]A [ ]B [ ]C [ ]D [ ]E [ ]F
4. [ ]A [ ]B [ ]C [ ]D [ ]E
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13. [ ]A [ ]B [ ]C [ ]D [ ]E
14. [ ]A [ ]B [ ]C [ ]D [ ]E [ ]F
15. [ ]A [ ]B [ ]C [ ]D
16. [ ]A [ ]B [ ]C [ ]D [ ]E
17. [ ]A [ ]B [ ]C [ ]D [ ]E
18. [ ]A [ ]B [ ]C [ ]D [ ]E
19. [ ]A [ ]B [ ]C [ ]D [ ]E
20. [ ]A [ ]B [ ]C [ ]D [ ]E
21. [ ]A [ ]B [ ]C [ ]D [ ]E
22. [ ]A [ ]B [ ]C [ ]D [ ]E
23. [ ]A [ ]B [ ]C [ ]D [ ]E
24. [ ]A [ ]B [ ]C [ ]D [ ]E
25. [ ]A [ ]B [ ]C [ ]D [ ]E
26. [ ]A [ ]B [ ]C [ ]D [ ]E
27. [ ]A [ ]B [ ]C [ ]D [ ]E [ ]F

Signature *Date / Completed Exam*

22. The teaching strategies used in this report (text, figures, boxes, and tables) were useful.

A. Strongly agree.
B. Agree.
C. Neither agree nor disagree.
D. Disagree.
E. Strongly disagree.

23. Overall, the presentation of the report enhanced my ability to understand the material.

A. Strongly agree.
B. Agree.
C. Neither agree nor disagree.
D. Disagree.
E. Strongly disagree.

24. These recommendations will affect my practice.

A. Strongly agree.
B. Agree.
C. Neither agree nor disagree.
D. Disagree.
E. Strongly disagree.

25. The content of this activity was appropriate for my educational needs.

A. Strongly agree.
B. Agree.
C. Neither agree nor disagree.
D. Disagree.
E. Strongly disagree.

26. The availability of continuing education credit influenced my decision to read this report.

A. Strongly agree.
B. Agree.
C. Neither agree nor disagree.
D. Disagree.
E. Strongly disagree.

27. How did you learn about this continuing education activity?

A. Internet.
B. Advertisement (e.g., fact sheet, *MMWR* cover, newsletter, or journal).
C. Coworker/supervisor.
D. Conference presentation.
E. *MMWR* subscription.
F. Other.

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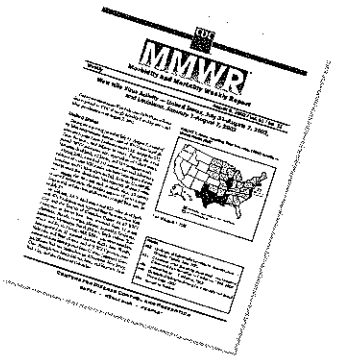

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☆U.S. Government Printing Office: 2004-633-140/4-00056 Region IV ISSN: 1057-5987