Draft Recommended Infection Control Practices for Dentistry, 2003

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Draft Recommended Infection Control Practices for Dentistry, 2003

Summary

Draft Recommended Infection Control Practices for Dentistry, 2003 consolidates recommendations for the prevention and control of infectious diseases and the management of occupational health and safety issues related to infection control in dental settings. This document: 1) updates and revises previous recommendations of the Centers for Disease Control and Prevention (CDC) regarding infection control for dental settings (CDC 1986, CDC 1993); 2) incorporates relevant infection control measures from several other CDC guidelines (Table 1); and 3) discusses several issues not addressed in previous CDC recommendations for dentistry. These updates and additional topics include:

- Standard precautions
- Work restrictions for health-care personnel occupationally exposed to or infected with infectious diseases (Appendix 3)
- Management of occupational exposures to bloodborne pathogens, including postexposure prophylaxis (PEP)
- Selection and use of devices with features engineered to prevent sharps injury
- Transmissible spongiform encephalopathies (TSEs)
- Hand hygiene products and surgical hand antisepsis
- Contact dermatitis and latex hypersensitivity
- Flash sterilization limitations
- Dental water quality
- Boil-water advisories
- Discontinued flushing dental unit waterlines at the beginning of the day
- Program evaluation
- Aseptic technique for parenteral medications
- Pre-procedural mouth rinsing for patients
- Definition of a surgical procedure
- Use of sterile water for surgical procedures
- Further research needs (Appendix 5)

These recommendations represent a consensus from a panel of experts in infection control regarding strategies for the prevention of disease transmission in dental health-care settings. Whenever possible, the recommendations are based on data from well-designed scientific studies. Only a few studies, however, have characterized risk factors and the effectiveness of prevention measures for infections associated with dental healthcare. Because transmission of infectious agents should be similar in dental and medical settings, pertinent sections of infection control recommendations from other CDC guidelines have been included where applicable (Table 1). Infection control updates are continually published in the literature. Thus, CDC recommends that readers review future publications of new or updated guidelines and documents to stay apprised of current infection control recommendations (Appendix 1).

Some infection control practices routinely used by dental practitioners (e.g., use of sterile water for surgical procedures) cannot be rigorously studied for ethical or logistical reasons (due to attaining an adequate sample size). In the absence of proven scientific evidence for certain practices, some recommendations are based on a strong theoretical rationale, suggestive evidence, or the opinions of respected authorities based on clinical experience, descriptive studies, or reports of expert committees. In addition, some recommendations are derived from existing federal regulations. No recommendation is offered for some practices for which there is insufficient scientific evidence or lack of expert consensus supporting their effectiveness. For practices related to unresolved issues, practitioners should formulate a policy within their own facility.

Table 1. Referenced Guidelines for Infection Control for Health-Care Settings

Document Title	Year	Author	Advisory Committee
Guidelines for Handwashing and Hospital Environmental Control	1985	Garner	None
Recommendations for Preventing Transmission of Human Immunodeficiency Virus and Hepatitis B Virus to Patients During Exposure-Prone Invasive Procedures	1991	CDC	None
Guidelines for Preventing the Transmission of *Mycobacterium tuberculosis* in Health-care Facilities	1994	CDC	None
Guideline for Hand Washing and Hand Antisepsis in Health-Care Settings	1995	Larson	APIC*
Guideline for Isolation Precautions in Hospitals	1996	Garner	HICPAC†
Guideline for Selection and Use of Disinfectants	1996	Rutala	APIC*
Immunization of Health-Care Workers	1997	CDC	ACIP§/HICPAC†
Guideline for Infection Control in Health-Care Personnel	1998	Bolyard	HICPAC†
Guideline for Prevention of Surgical Site Infection	1999	Mangram	HICPAC†
Recommendations for Infection Control for the Practice of Anesthesiology	1999	ASA#	None
Updated US Public Health Service Guidelines for the Management of Occupational Exposures to HBV, HCV, and HIV and Recommendations for Postexposure Prophylaxis	2001	CDC	HICPAC†
Draft Guideline for Environmental Infection Control in Health-Care Facilities	2001	CDC	HICPAC†
Draft Guideline for Cleaning, Disinfection, and Sterilization in Health-Care	2002	Rutala	HICPAC†
Guideline for Hand Hygiene in Health-Care Settings	2002	CDC	HICPAC†
Guidelines for the Prevention of Intravascular Catheter-Related Infections	2002	CDC	HICPAC†

* Association for Professionals in Infection Control and Epidemiology, Inc.
† Healthcare Infection Control Practices Advisory Committee, formerly the Hospital Infection Control Practices Advisory Committee (national advisory committee to CDC).
§ Advisory Committee on Immunization Practices (national advisory committee to CDC).
# American Society of Anesthesiologists

Introduction

In the United States an estimated 9.0 million persons work in health-care professions (health-care personnel [HCP]), including approximately 168,000 dentists, 112,000 registered dental hygienists, 218,000 dental assistants (US Census Bureau 2001), and 53,000 dental laboratory technicians (HRSA 2000). In this document the term dental health-care personnel (DHCP) refers to all paid and unpaid personnel in the dental health-care setting who could be occupationally exposed to infectious materials, including body substances, and contaminated supplies, equipment, environmental surfaces, water, or air. These personnel include dental hygienists, dental assistants, dental laboratory technicians, students and trainees, contractual staff, and other

persons not directly involved in patient care but potentially exposed to infectious agents (e.g., administrative, clerical, housekeeping, maintenance, volunteer personnel). These recommendations are designed to prevent or reduce the 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 may be exposed to a variety of microorganisms in blood, oral, or respiratory secretions, including cytomegalovirus (CMV), hepatitis B virus (HBV), hepatitis C virus (HCV), herpes simplex virus types 1 and 2, human immunodeficiency virus (HIV), *Mycobacterium tuberculosis* (*M. tuberculosis*), staphylococci, streptococci, and other viruses and bacteria that colonize or infect the oral cavity and respiratory tract. Infections may be transmitted in dental settings through several routes, including direct contact with blood, oral fluids, or other body fluids; indirect contact with contaminated instruments, operatory equipment, or environmental surfaces; and contact with airborne contaminants present in either droplet, spatter, or aerosols of oral and respiratory fluids. Infection via any of these routes requires that all of the following conditions be present: 1) a pathogenic organism of sufficient virulence and in adequate numbers (i.e., dosage) to cause disease; 2) a suitable reservoir or source that allows the pathogen to survive and multiply (e.g., blood); 3) a mode of escape from the reservoir; 4) a mechanism of transmission from the source to the host; 5) a portal of entry through which the pathogen may enter the host; and 6) a susceptible host (i.e., one who is not immune). The occurrence of these events is considered the “chain” of infection. Effective infection control strategies are intended to break one or more of these "links" in the chain, thereby preventing infection. Such strategies include: vaccinations; hand hygiene and barrier precautions; proper cleaning, disinfection, and sterilization procedures; and aseptic techniques and practices (e.g., the use of safer devices and behaviors) to reduce the risk of exposure to blood, other body fluids, or infectious agents.

Previous CDC recommendations on infection control for dentistry focused primarily on the use of universal precautions to reduce the risk of transmission of bloodborne pathogens among DHCP and patients (CDC 1986, CDC 1988, CDC 1989, CDC 1993). Because many patients with bloodborne infections are asymptomatic or unaware that they are infected, these recommendations emphasized the need to treat blood and other body fluids contaminated with blood from all patients as potentially infectious (Garner 1985, CDC 1986, CDC 1987, CDC 1988, CDC 1989, CDC 1993). In 1996, CDC developed guidelines that combined the major components of universal precautions and body substance isolation (designed to reduce the risk of transmission of pathogens from moist body substances) into one set of precautions known as standard precautions (Garner 1996). Standard precautions are similar to universal precautions in that they are designed to reduce the risk of transmission of pathogens from both recognized and unrecognized sources of infection to other patients and to DHCP. Standard precautions apply to contact with 1) blood; 2) all body fluids, secretions, and excretions except sweat, regardless of whether they contain blood; 3) non-intact skin; and 4) mucous membranes. Standard precautions should be used in the care of all patients, regardless of their infection status.

For the vast majority of infectious diseases, standard precautions are adequate. Additional precautions (transmission-based precautions) are necessary for interrupting the spread of certain diseases (e.g., tuberculosis, influenza, chicken pox) transmitted by air, droplets, or indirect or

direct contact with contaminated sources (Garner 1996, Bolyard 1998). Such precautions can include patient placement (e.g., isolation), adequate room ventilation, respiratory protection for workers, and postponement of non-emergent dental procedures. Precautions for preventing the transmission of tuberculosis in dental health-care settings are discussed in a section entitled Preventing the Transmission of *Mycobacterium tuberculosis*.

Dental facilities should develop a written infection control program to prevent or reduce the risk of disease transmission. This should include an Exposure Control Plan to eliminate or minimize employee exposure (OSHA 1991). Such a program should include the establishment and implementation of policies, procedures, and practices (in conjunction with the selection and use of technologies and products) to prevent work-related injuries and illnesses in health-care personnel as well as health-care-associated infections in patients. The program should: 1) embody the principles of infection control and occupational health; 2) reflect current science; 3) adhere to relevant federal, state, and local regulations and statutes; and 4) be reviewed and updated at least annually. An infection control coordinator (e.g., a dentist or other staff member) knowledgeable or willing to be trained in the principles of infection control should be assigned responsibility for coordinating the program. Strategies and tools can be developed and used to evaluate the effectiveness of the infection control program (such strategies will be addressed in the section entitled Program Evaluation).

Resources are available to DHCP regarding the proper procedures for handling or working with a particular substance (e.g. chemical) and are not discussed in this guideline. Product information about physical data, health effects, first aid, reactivity, storage, disposal, and spill/leak procedures can be referenced in the manufacturer's Material Safety Data Sheet (MSDS) and should be available to all employees (OSHA 1994).

Part I. Review of the Scientific Data Regarding Dental Infection Control

Infection Control Elements of a Personnel Health Program

An occupational personnel health program for DHCP is an integral part of the infection control program. The infection control objectives of the program are to educate DHCP about the principles of infection control, to identify work-related infection risks and institute appropriate preventive measures, and to ensure prompt and appropriate provision of preventive services for exposure management and medical follow-up. These preventive services will be part of the occupational personnel health program, and coordination between the attending dental professional and other qualified health-care professionals will be important in providing DHCP with appropriate services. Dental programs in institutional settings, such as hospitals, health centers, and educational institutions, can coordinate with other departments that provide personnel health services. Most dental practices, however, are in ambulatory, private settings that do not have the appropriately licensed staff and facilities to provide complete on-site health service programs. It is important that the responsible infection control coordinator in these settings establish programs that arrange site-specific infection control services with external health-care facilities and providers (e.g., qualified health-care professionals) before DHCP are placed at risk of exposure. Referral arrangements can be made with qualified health-care

professionals in an occupational health program of a hospital, 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 if they understand its rationale (Bolyard 1998, OSHA 1991, Gershon 2000). Clearly written policies, procedures, and guidelines can help ensure consistency, efficiency, and effective coordination of activities. Education and training in infection control should be appropriate to both the risk of exposure and assigned duties of specific personnel. For DHCP who perform tasks or procedures likely to result in occupational exposure to potentially infectious agents, training should include a description of their exposure risks; a review of prevention strategies, infection control policies and procedures for the facility; discussion on how to manage work-related illness and injuries, including postexposure prophylaxis (PEP); and a review of work restrictions appropriate for the exposure or infection. Inclusion of personnel with minimal exposure risks (e.g., administrative staff) in education and training programs may enhance facility-wide understanding of infection control principles and the importance of the program. Educational materials should be appropriate in content and vocabulary for the person's educational level, literacy, and language and consistent with existing federal, state, and local regulations (Bolyard 1998).

Immunization Programs

DHCP are at risk for exposure to, and possible infection with, vaccine-preventable diseases. Appropriate immunizations substantially reduce both the number of DHCP susceptible to these diseases and the potential for disease transmission to other DHCP and patients (Bolyard 1998, CDC/ACIP 1997). Thus, immunizations are an essential part of prevention and infection control programs for DHCP and dental health-care facilities are encouraged to formulate a comprehensive immunization policy (AHA 1992, CDC/ACIP 1997). These policies should include a checklist of required and recommended vaccinations for specific job categories, including appropriate vaccination and booster schedules; determination of the immune status of newly hired employees; and considerations for DHCP unable or unwilling to be vaccinated as required or recommended. Policies also should reflect the regulations and recommendations on the vaccination of HCP established by individual states and professional organizations.

Immunization of DHCP before they are placed at risk remains the most efficient and effective use of vaccines in health-care settings. Many professional educational institutions and site-specific infection control programs provide appropriate immunization schedules for students and practicing DHCP. Personnel who do not provide direct patient care (e.g., administrators, laboratory personnel) but come into contact with patients, patient materials, and other DHCP also should receive recommended vaccinations. DHCP unable or unwilling to be vaccinated as required or recommended should be educated on 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.

National guidelines for immunization of, and PEP for, HCP, which includes DHCP, are provided by the US Public Health Service's Advisory Committee on Immunization Practices (ACIP) (CDC/ACIP 1997 and 2001). Based on studies of health-care infections, susceptible HCP are considered to be at occupational risk for acquiring HBV or HCV infection, and at risk for

acquiring or transmitting influenza, measles, mumps, rubella, and chicken pox (varicella). The ACIP recommends that all HCP be vaccinated or have documented immunity to all vaccine-preventable diseases (Bolyard 1998, CDC/ACIP 1997) (Appendix 2). The committee does not recommend routine immunization of HCP against tuberculosis (i.e., inoculation with Bacille Calmette-Guérin [BCG] vaccine) or hepatitis A (CDC/ACIP 1997). ACIP guidelines also provide recommendations on immunization of HCP with special conditions (e.g., pregnancy, HIV infection, diabetes) (Bolyard 1998, CDC/ACIP 1997).

Exposure Prevention and Postexposure Management

Avoiding exposure to blood and other potentially infectious body fluids, as well as protection by immunization, remain primary strategies for reducing occupationally acquired infections, but occupational exposures will still occur (MMWR 2001). A combination of standard precautions and administrative, engineering, and work practice controls is the best means of eliminating or minimizing occupational exposures. Written policies and procedures to facilitate the 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 (OSHA 1991).

Recommendations for postexposure management and prophylaxis for exposures to blood are addressed in the section entitled Preventing the Transmission of Bloodborne Pathogens. DHCP may have contact with persons suspected or confirmed infectious tuberculosis and should have a baseline tuberculin skin test (preferably using a two-step test) at the beginning of employment. If an unprotected exposure occurs, tuberculin skin test (TST) conversions can be distinguished from positive TST results caused by previous exposures (CDC tuberculosis 1994, Cleveland 1995). The facility's level of TB risk will determine the need for routine follow-up TST. Further information is addressed in the section entitled Preventing the Transmission of *Mycobacterium tuberculosis*.

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 more susceptible to opportunistic infection) should discuss with their personal physician or other qualified authority whether the condition may affect their ability to safely perform their duties. Under certain circumstances, however, health-care facilities may need to implement additional measures to prevent further transmission of infection that warrant exclusion of personnel from work or patient contact (Herwaldt 1997). Decisions on work restrictions are based on the mode of transmission and the epidemiology of the disease (Bolyard 1998) (Appendix 3). Exclusion policies should be written, include a statement of authority defining who may exclude personnel (e.g., personal physician), and be clearly communicated to personnel through education and training. Policies also need to be designed to encourage personnel to report their illnesses or exposures and not to penalize them with loss of wages, benefits, or job status.

With increasing concerns about bloodborne pathogens and the introduction of universal precautions, the use of latex gloves among health-care workers has increased markedly (CDC 1988, Nash 1992). Increased use of these gloves has been accompanied by more reports of

allergic reactions to natural rubber latex among HCP (including DHCP) and patients (Berky 1992, Bubak 1992, Fisher 1992, Smart 1992, Yassin 1994, Zaza 1994, Hunt 1995).

DHCP should be familiar with the signs and symptoms of latex sensitivity (Bolyard 1998, American Dental Association 1999, CDC NIOSH 1997, Terezhalmy Personal 1996). A physician should evaluate DHCP experiencing symptoms of latex allergy, because further exposure could result in a serious allergic reaction. A diagnosis is made through the medical history, physical examination, and tests. Procedures should be in place for minimizing latex-related health problems in DHCP and patients while protecting them from infectious materials. These procedures include reducing exposures to latex containing materials, using appropriate work practices, training and educating DHCP, monitoring symptoms, and substituting non-latex products when appropriate (CDC/NIOSH 1997). Further information on contact dermatitis in DHCP and patients can be found in the section entitled Contact Dermatitis and Latex Hypersensitivity.

Maintenance of Records, Data Management, and Confidentiality

Maintenance of records on work-related medical evaluations, screening tests, immunizations, exposures, and post exposure management allows monitoring of the health status of personnel. Such records must be kept in accordance with all applicable state and federal laws. Some examples of laws that may apply, include the Privacy Rule of the Health Insurance Portability and Accountability Act of 1996, 45 C.F.R. 160 & 164 (HIPAA) and the Occupational Safety and Health Administration (OSHA) Occupational Exposure to Bloodborne Pathogens; Final Rule 29 C.F.R. 1910.1030(h)(1)(i–iv) (HIPAA 2000, OSHA 1991). HIPAA applies to covered entities including certain health providers, health care clearinghouses, and health plans as defined by the Privacy Rule. OSHA also requires that employers ensure that certain information contained in employee medical records are: 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 this Final Rule or as may be required by law, and 3) maintained by the employer for at least the duration of employment plus 30 years. Dental facilities that coordinate their infection control program with off-site providers may want to consult OSHA's Final Rule mentioned above and other applicable local, state, and federal laws in order to determine the preferable location to maintain health records.

Preventing Transmission of Bloodborne Pathogens

The transmission of bloodborne pathogens (e.g., HIV, HBV, and HCV) in dental health-care settings can have serious consequences but is fortunately a rare event. Transmission can occur as a result of exposure to infected blood; from patient-to-DHCP, from DHCP-to-patient, and from one patient to another. The opportunity for transmission is most likely from patient to DHCP, who frequently contact patient blood and blood-contaminated saliva during dental procedures. 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 afflicted with dermatitis). The risk of occupational exposure to bloodborne viruses is largely determined by their prevalence (frequency) 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 (i.e., viral titer in the source, volume of material), route of exposure, and susceptibility of the exposed HCP (Chiarello 2001).

Avoiding occupational exposures to blood is the primary way to prevent transmission of HBV, HCV, and HIV to HCP in health-care settings (CDC NIOSH 1999). Methods to reduce the risk of blood contacts have included the use of standard precautions (which incorporates universal precautions), modifications of work practices, and more recently, the use of devices with features engineered to prevent sharp injuries. These three measures have been proved effective in decreasing percutaneous injuries among dentists over recent years (Klein 1988; Gruninger 1992; Siew 1995; Cleveland 1997), but needlesticks and other blood contacts continue to occur, a concern because percutaneous injuries pose the greatest risk of transmission. A comprehensive program to prevent sharps injuries and infection following occupational blood exposures includes immunization against HBV and prompt postexposure management.

Hepatitis B Virus

HBV is a well-recognized occupational risk for DHCP. Among HCP, occupational infections have declined over the past two decades because of the use of vaccine and adherence to the use of universal precautions (Shapiro 1995). Of U.S. dentists, over 90% have been vaccinated, and serologic evidence of past HBV infection decreased from pre-vaccine levels of 14% in 1972 to 8-9% in 1989 (Cleveland 1996). From 1989 to 2001, levels remained relatively unchanged (Chakwan Siew, PhD, American Dental Association, Chicago, IL, personal communication, November 2002). It is reasonable to expect that infection rates will decline further as vaccinations 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 dental personnel to patients is considered very small, (CDC 1991, Chamberland 1992, Robert 1995), precise risks have not been quantified by carefully designed epidemiologic studies (CDC dentistry 1993, CDC 1991 exposure prone, Siew 1992). Reports published from 1970 through 1987 indicate nine clusters in which patients were thought to be infected with HBV through treatment by an infected DHCP (Ahtone 1983, Hadler 1981, CDC 1985, Levin 1974, Rimland 1977, Goodwin 1976, Reingold 1982, Goodman 1982, Shaw 1986, CDC 1987 hepatitis B). Transmission of HBV from dentist to patient has not been reported since 1987, however, possibly reflecting such factors as incomplete ascertainment and reporting, improved adherence to other preventive measures (e.g., standard precautions–including routine glove use by dentists), and increased levels of immunity due to use of hepatitis B vaccine. Furthermore, since the adoption of universal precautions and the implementation of the Occupational Safety and Health Administration's Occupational Exposure to Bloodborne Pathogens: Final Rule in 1991, there has only been one documented case of patient-to-patient transmission of hepatitis B virus in the dental setting (Redd 2003).

HBV is transmitted by percutaneous or mucosal exposure to blood or body fluids of a person with either acute or chronic HBV infection. A person who is infected with HBV can transmit the virus for as long as they are hepatitis B surface antigen (HBsAg) positive. In addition, if the source is also positive for hepatitis B e antigen (HBeAg), the risk of infection is 10 times higher

than for exposure to a source positive for HBsAg alone (Werner 1982). Because of the high risk of HBV infection among HCP, DHCP who perform tasks involving contact with blood, blood-contaminated body fluids, other body fluids, or sharps should be vaccinated (CDC 1991 Hepatitis B virus: a comprehensive strategy, CDC dentistry 1993, CDC Immunization 1997, OSHA 1991). Vaccination can protect both DHCP and patients from HBV infection and should be completed when dentists or other DHCP are still in their training program and before they have contact with blood. Pre-vaccination serological testing for previous infection is not indicated for persons being vaccinated because they have an occupational risk, though it would be useful in individuals who have immigrated from areas with high rates of HBV infection. DHCP should be tested for antibody to HBsAg (anti-HBs) 1 to 2 months after completion of the 3-dose vaccination series (CDC Immunization 1997). Knowledge of the antibody response aids in determining appropriate PEP or the need for additional vaccine doses (CDC Immunization 1997). DHCP who do not respond adequately to the vaccine should complete a second 3-dose series (CDC Immunization 1997). Approximately half of nonresponders to the primary series will respond to a second series. Persons in whom a protective antibody response (>10mIU/ml) develops 1–2 months after completion of the 3-dose or 6-dose series of vaccinations, are considered immune. If there is no antibody response after the second series, testing for HBsAg should be performed (CDC Immunization 1997).

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 (CDC Immunization 1997). Booster doses of vaccine and periodic serologic testing to monitor antibody concentrations after completion of the vaccine series are not necessary for vaccine responders (CDC Immunization 1997).

Hepatitis C Virus

HCV is not transmitted efficiently through occupational exposures to blood. Follow-up studies of HCP exposed to HCV-infected blood through percutaneous or other sharps injuries have found a low incidence of seroconversion (mean, 1.8%; range, 0%-7%) (Alter 1997, Puro 1995, Lanphear 1994, Mitsui 1992). One study found that transmission occurred from hollow-bore needles but not other sharps (Puro 1995). Although these studies have not documented seroconversion associated with mucous membrane or nonintact skin exposure, at least two cases of transmission of HCV from a blood splash to the conjunctiva (Sartori 1993, Ippolito 1998) and one case of simultaneous transmission of HCV and HIV after nonintact skin exposure have been reported (Beltrami 2002). There is little data to allow estimation of the occupational risk of HCV infection among HCP, but most studies suggest that the prevalence of HCV infection among dentists, surgeons, and hospital-based HCP is similar to that among the general population, about 1-2%, and is 1/10 that of HBV infection (Cooper 1992, Panlilio 1995, Polish 1993, Shapiro 1996, Gerberding 1994, Klein 1991, Thomas 1996, Cleveland 1999, Gruninger 2001). In a study that evaluated risk factors for infection, a history of accidental needlesticks was the only occupational risk factor independently associated with HCV infection (Polish 1993).

Human Immunodeficiency Virus

The risk of HIV transmission in dental settings appears to be extremely low. As of June 2001 there were 57 U.S. HCP but no DHCP with documented HIV seroconversion following a

specific occupational exposure to a known HIV-infected source (CDC 2001). Transmission of HIV to six patients of a single dentist with AIDS has been reported, but the mode of transmission could not be determined (CDC dentistry 1993, CDC investigation 1993, Ciesielski 1992). As of September 30, 1993, CDC was aware of test results of more than 22,000 patients of 63 HIV-infected HCP, including 33 dentists or dental students (Robert 1995, CDC investigation 1993). No additional cases of transmission were documented during these extensive investigations.

Prospective studies worldwide indicate that the average risk of HIV infection after a single percutaneous exposure to HIV-infected blood is 0.3% (range: 0.2%-0.5%) (Bell 1997) after an exposure of mucous membranes in the eye, nose, or mouth, the risk is approximately 0.1% (Ippolito 1993). The precise risk of transmission after skin exposures remains unknown but is believed to be even smaller.

Several factors affect the risk of HIV transmission after an occupational exposure. Laboratory studies have found that 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 (Mast 1993). 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), 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 (Cardo 1997). The risk was also increased if the exposure was to blood from patients with terminal illness, possibly reflecting the higher titer of HIV in late-stage AIDS.

Preventing and Managing Exposures to Blood

From 1990 to 1998, the US Public Health Service (USPHS) published several guidelines for the management of exposures to HBV, HCV, or HIV that included considerations for PEP and management (CDC 1990, CDC 1991 Hepatitis B virus: a comprehensive strategy, CDC 1996, CDC 1998 control of hepatitis C, CDC 1998 exposure HIV). In 2001, the USPHS consolidated into one set of guidelines all previous USPHS recommendations. Current guidelines reflect the availability of new antiretroviral agents, new information about the use and safety of HIV PEP, and considerations about employing HIV PEP when resistance of the source patient's virus to antiretroviral agents is known or suspected. In addition, the 2001 document provides guidance to clinicians and exposed HCP on deciding when to consider HIV PEP and recommendations for PEP regimens. The USPHS will periodically review scientific information on antiretroviral therapies and publish updated recommendations for their use as PEP (CDC 2001).

Risk of Percutaneous Injury Among DHCP

Observational studies and surveys indicate that percutaneous injuries among general dentists not only occur less frequently than among general and orthopedic surgeons but also that they have decreased in frequency since the mid-1980s (Klein 1988, Gruninger 1992, Cleveland 1995, Siew 1995). This decline has been attributed to safer work practices, safer instrumentation or design, and continued worker education (Cleveland 1997, Gooch 1998). Percutaneous injuries among dental personnel generally occur outside the patient's mouth, involve very small amounts of blood, and are caused by burs, syringe needles, and other sharp instruments (Gruninger 1992, Cleveland 1995, Gooch 1995, Siew 1995). Among oral surgeons, limited data suggest that injuries may occur more frequently during fracture reductions using wires (Gooch 1998, Carlton

1997). Experience, as measured by years in practice, does not appear to affect the risk of injury among general dentists or oral surgeons (Siew 1995, Carlton 1997, Gooch 1998).

From June 1995 to March 2000, participating dentists, oral surgeons, hygienists, and dental assistants reported 104 percutaneous injuries to CDC's National Surveillance System for Health-care Workers (NaSH) (CDC unpublished data). Small-gauge syringe needles caused 28% of injuries, overall representing 35% of injuries among assistants, 30% among dentists, and 26% among oral surgeons. Most injuries (97%) were superficial to moderately deep; only 3% were described as deep punctures or wounds. Less than half of syringe needles, burs, and scalpels were visibly contaminated with blood prior to the injury. In contrast, most of the suture needles and scalers were visibly bloody. More than half (54%) of all injuries occurred during use of the device. Injuries with syringe needles frequently occurred during insertion or withdrawal of the needle or when the patient moved unexpectedly (46%); 19% took place during recapping and 19% during cleanup; 10% were environmentally related (involved bumping into an exposed syringe needle left in an unexpected location); and 6% occurred during passing or handling. None took place while the DHCP was putting the syringe needle into a sharps container, as often occurs in medical practice settings.

Prevention Methods

Most exposures are preventable. Methods used to prevent occupational exposures in dental settings include standard precautions, engineering and work practice controls, and the use of personal protective equipment.

Whenever possible, engineering controls should be the primary method to reduce exposures to bloodborne pathogens with sharp instruments and needles. These controls are frequently technology based and often incorporate safer designs of instruments and devices, (such as self-sheathing anesthetic needles and dental units designed to shield burs in handpieces) to reduce percutaneous injuries (Cleveland 1995, Cleveland 1997, Harte 1998). Used disposable syringes and needles, scalpel blades, and other sharp items should be placed in appropriate puncture-resistant containers located as close as practical to where the items were used (CDC HIV 1987, CDC 1988, CDC 1989, CDC dentistry 1993, CDC NIOSH Containers 1998).

Work practice controls should incorporate specific work practices to protect personnel whose responsibilities include handling, using, assembling, or processing sharp devices or sharps disposal containers. Used needles should never be recapped or otherwise manipulated using both hands or any other technique that involves directing the point of a needle toward any part of the body (CDC HIV 1987, CDC 1988, CDC 1989, CDC dentistry 1993, OSHA 1991, NIOSH 1999). Either a one-handed "scoop" technique or a mechanical device designed for holding the needle sheath should be employed (CDC HIV 1987, CDC 1988, CDC 1989, CDC 1993, OSHA 1991). DHCP should never bend or break needles before disposal as this practice requires unnecessary manipulation. Before attempting to remove needles from non disposable aspirating syringes, DHCP should recap them to prevent injuries. Either of the two acceptable techniques may be used. For procedures involving multiple injections with a single needle, the unsheathed needle should be placed in a location where it will not become contaminated or contribute to unintentional needlesticks between injections. Other work practice controls include removing burs before disassembling the handpiece from the dental unit, restricting the use of fingers during

suturing and administration of anesthesia, and minimizing potentially uncontrolled movements of instruments such as scalers or laboratory knives (Gooch 1995, Cleveland 1995).

Personal protective equipment, such as gloves, masks, protective eyewear with solid side shields, and gowns, is intended to prevent skin and mucous membrane exposures. Other protective equipment, such as plastic finger guards, has been suggested to reduce injuries during dental procedures (Gooch 1998).

Mandated by the Needlestick Safety and Prevention Act [Public Law No. 106-430, November 6, 2000], changes to OSHA's bloodborne pathogens standard were published January 18, 2001, and became effective April 18, 2001 (OSHA 2001 needlestick, OSHA 2001 CPL). The revisions clarify the need for employers to select safer needle devices as they become available and to involve employees in identifying and choosing such devices (OSHA needlestick 2001). Many safer versions of sharp devices used in hospital settings have become available, and their impact on reducing injuries has been studied (CDC 1997 blunt suture needles, CDC 1997 phlebotomy procedures). Aspirating anesthetic syringes that incorporate safety features have been developed for dental cases, but the low injury rates in dentistry limit assessment of their effect on reducing injuries among DHCP. Nonetheless, the impact of safer medical devices in other settings suggests that devices with engineered safety features could reduce percutaneous injuries in dental settings as well.

A program to prevent sharps injuries that includes a process to identify, screen, and evaluate safer dental devices should be developed by all dental practices and integrated into existing infection control and safety programs. The infection control coordinator should identify a team to develop, implement, and monitor the safety program. Under the revised OSHA bloodborne pathogen standard, this team should include employees directly responsible for patient care (e.g., dentists, hygienists, and dental assistants) (Department 2001 Federal Register, Department 2001 CPL). The following activities are important elements of a successful safety program:

- Promote safety awareness by encouraging management and employees to actively participate in ensuring a safe workplace.
- Facilitate prompt reporting and post exposure management of injuries.
- Identify unsafe work practices and devices.
- Determine intervention priorities.
- Coordinate the identification, screening, and evaluation of devices to prevent sharps injury.
- Organize staff education and training.
- Complete the necessary reporting forms and documentation.
- Monitor safety performance.

These activities should be developed into a written plan, and mechanisms for staff feedback should be provided. Such feedback will assist the infection control coordinator in reviewing the effectiveness of the plan and in making modifications as needed. Although the infection control coordinator is responsible for the overall management of the program, creating a safe work environment ultimately will require the commitment and accountability of all DHCP. The US Food and Drug Administration (FDA) is responsible for regulating medical products, including drugs, devices (such as medical and dental instruments), and biological products. FDA

encourages the reporting of a problem or an adverse event associated with medical or dental products. To report such an event, contact MedWatch (telephone: 1-800-FDA-1088; Web site: www.fda.gov/medwatch/index.html). The identities of both patients and persons who make the reports will be kept confidential upon request. Accidental needlesticks are not reported to MedWatch but are reported through mechanisms established in the Exposure Control Plan. Additional information for developing a safety program and for identifying and evaluating safer dental devices can be found at the following web sites:

- Forms for screening and evaluating safer dental devices: http://www.cdc.gov/OralHealth/infection_control/forms.htm
- Current list of available safer dental devices: http://www.osap.org
- State legislation on needlestick safety: http://www.cdc.gov/niosh

Postexposure Management

Postexposure management is an integral component of a complete program to prevent infection after an occupational exposure to blood. During dental procedures it is predictable that saliva will be contaminated with blood (CDC 1988, CDC 1989). If blood is not visible, it is likely that it is still present in very small quantities and the risk for transmission of HBV, HCV, and HIV is extremely small (CDC 2001). Despite this small risk, a qualified health-care professional should evaluate any occupational exposure incident to saliva in dental settings, regardless of whether any blood is visible (OSHA 1991).

Dental practices should establish a written, comprehensive program that includes hepatitis B vaccination and postexposure management protocols that: 1) describe the types of blood contact that may 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 the most current recommendations of the USPHS, including PEP when indicated. DHCP (including students) who might reasonably be considered at risk of occupational exposure to blood or other potentially infectious fluids should be taught strategies to prevent blood contacts and the principles of postexposure management, including options for PEP, as part of their job orientation and ongoing training. Educational programs for dental staff and students should emphasize reporting all exposures as soon as possible, because certain interventions must be initiated promptly to be effective. Policies must be consistent with the practices and procedures for worker protection required by OSHA and with current USPHS recommendations for managing occupational exposures to blood (CDC 2001, OSHA 1991, OSHA 2001 CPL).

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 (CDC 2001). Exposed personnel should immediately report the exposure to the infection control coordinator, who should initiate referral to the qualified health-care professional and complete necessary reports. Because many factors contribute to the risk of infection after an occupational exposure to blood, the following information must 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, by the estimated volume of material, duration of contact, and the condition of the skin (e.g., chapped, abraded, or intact).
- Details about the exposure source: 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 about the exposed person (e.g., hepatitis B vaccination and vaccine-response status).
- Details about counseling, postexposure management, and follow-up.

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

- The type and amount of body substance involved.
- The type of exposure (e.g., percutaneous injury, mucous membrane or non-intact skin exposure, bites resulting in blood exposure to either person involved).
- The infection status of the source.
- The susceptibility of the exposed person (CDC 2001).

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

Preventing Transmission of *Mycobacterium tuberculosis*

Patients infected with *M. tuberculosis* (TB) occasionally present at outpatient dental settings for urgent dental treatment. Understanding the pathogenesis of the development of TB will help the DHCP to make decisions on managing such patients.

M. tuberculosis is a bacterium carried in airborne particles, called droplet nuclei, that can be aerosolized from persons with pulmonary or laryngeal TB. These small particles (1-5 μ) can stay suspended in the air for several hours (Wells 1955). Infection could occur if a susceptible person inhales the 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*, the immune response prevents further spread of the TB bacteria, although the bacteria remain alive in the lungs for many years, a condition termed latent TB infection (LTBI). Persons with LTBI usually demonstrate a reactive tuberculin skin test (TST), have no symptoms of active disease, and are not infectious, but they may 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 have not been treated for latent TB infection will progress from infection to active disease in the first year or two after infection; another 5% will develop active disease much later in life. Thus, about 90% of U.S.

persons with latent TB infection do not progress to active TB disease. Some immunocompromised medical conditions such as HIV, increase the risk that TB infection will progress to active disease at a faster rate (CDC 1998). A person with active TB disease has clinical symptoms, is contagious, and can transmit TB to others. Symptoms of active TB disease include a productive cough, night sweats, fatigue, malaise, fever, and unexplained weight loss.

Both latent TB infection and active TB disease are described as TB, but only the person with active disease is contagious and presents a risk of transmission in the dental health-care setting.

Risk of Transmission

Transmission of TB is via airborne exposure and standard precautions are not sufficient to prevent transmission. Recommendations for additional precautions to prevent transmission of *M. tuberculosis* and other organisms that may be spread by airborne, droplet or contact routes are covered in detail elsewhere (Bolyard 1996, Garner 1996).

Overall, the risk borne by DHCP for exposure to a patient with active TB disease is probably quite low (CDC 1994, Cleveland 1995). There has been only one report of TB transmission in a dental office (Smith 1982), and TST conversions among DHCP also appear low (CDC 1994 tuberculin, Mikitka 1995). In some instances, the community population served by the dental facility or the DHCP, may be at relatively high risk for TB.

TB transmission is controlled through a hierarchy of measures, which include 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. Because there is the potential for transmission of *M. tuberculosis* in dental settings, dental offices should develop a TB control program appropriate for their level of risk (CDC 1994, Cleveland 1995), including:

- A community risk assessment should be done 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 may have undiagnosed active TB; management of patients with active TB, relative to provision of urgent dental care; and employer-sponsored DHCP education, counseling, and tuberculin skin test screening.

- While taking patients' initial medical histories and at periodic updates, dental DHCPs should routinely ask all patients whether they have a history of TB disease and symptoms suggestive of TB.

- Patients with a medical history or symptoms suggestive 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 the dental condition and arrange a referral. While in the dental health-care facility, the patient should wait and be evaluated in a room with a closed door, wear a surgical mask when not being evaluated, or should be instructed to cover their mouth and nose when coughing or sneezing.

- Elective dental treatment should be deferred until a physician confirms that the patient does not have infectious TB. If the patient is diagnosed as having active TB, elective dental treatment should be deferred until the patient is no longer infectious.

- If urgent dental care must be provided for a patient who has, or is suspected of having active TB disease, the care should be provided in a previously identified facility that provides engineering controls such as TB isolation rooms and air filtration (e.g., hospital). Standard face masks do not protect against TB transmission. Respiratory protection (e.g., a fit-tested, disposable N-95 respirator) should be used by the DHCP.

- Any DHCP who has a persistent cough (i.e., a cough 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 for TB. The DHCP should not return to the workplace until a diagnosis of TB has been excluded or the DHCP is on therapy and a determination has been made that the DHCP is noninfectious.

Transmissible Spongiform Encephalopathies (Prion Diseases)

Transmissible spongiform encephalopathies (TSEs) are a group of rapidly progressive, invariably fatal, degenerative neurological disorders that affect both humans and animals and are thought to be caused by infection with prions. Prions are isoforms of a normal protein, and capable of self-replication, but they lack nucleic acid.

TSEs occur naturally in some animal species (e.g., sheep, goats, deer, elk), but they may also result from exposure of susceptible species (e.g., mink, cattle, felines) to infected animal tissues. Bovine spongiform encephalopathy (BSE), is a progressive neurological disorder of cattle commonly known as "mad cow disease." The major means of BSE transmission appears to be the consumption of prion-infected animal feed.

In humans, TSEs include Creutzfeldt-Jakob disease (CJD), Gerstmann-Straussler-Scheinker syndrome, fatal familial insomnia, kuru, and variant CJD (vCJD). Prion diseases have a long incubation period and are usually fatal within 1 year after onset. CJD occurs in sporadic, familial, and acquired (iatrogenic) forms and has an annual incidence in many countries of the world, including the United States, of approximately 1 case/million (CDC 1996, Johnson 1998). In about 85% of affected patients, CJD occurs as a sporadic disease with no recognizable pattern of transmission. A smaller proportion of patients (5-15%) develop familial CJD because of inherited mutations of the prion protein gene. According to published reports, iatrogenic transmission of CJD has occurred in humans under three circumstances: after use of contaminated EEG depth electrodes (Bernoulli 1977); after use of extracted pituitary hormones (Brown 1985, CDC 1985); and after implant of contaminated corneal (Duffy 1974) and dura mater grafts (CDC 1997, Thadani 1988) from humans. The equipment-related cases occurred before the routine implementation of sterilization procedures currently used in health-care facilities.

Both Gerstmann-Straussler-Scheinker syndrome and fatal familial insomnia are inherited. Kuru is not inherited and has been described only in the Fore population of New Guinea, but it has

almost disappeared since the cessation of ritualistic cannibalism that had facilitated disease transmission there (Gajdusek 1977, Gajdusek 1957, King 1975, Liberski 1997).

A new variant of CJD, vCJD, was reported first in the United Kingdom in 1996 (Will 1996) and subsequently in other European countries (World Health Organization 2001). To date, only one case of vCJD has been reported in the United States, in an immigrant from the United Kingdom (CDC Florida 2002, CDC MMWR Probably vCJD 2002). Although there is strong evidence that the agent responsible for vCJD is the same one responsible for the BSE outbreaks in cattle, the foods that may be associated with the transmission of this agent from cattle to humans are unknown. Compared to patients with CJD, patients with vCJD are younger (28 years vs. 68 years median age at death), and have a longer duration of illness (13 months vs. 4.5 months); in addition, they characteristically present with sensory and psychiatric symptoms that are uncommon with CJD. Another difference is that lymphoreticular tissues (e.g., tonsil) are consistently infected with prions in vCJD patients (Hill 1999).

CJD is a transmissible disease but it cannot be transmitted through the air, or through casual contact. As for iatrogenic CJD, all known cases 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 are considered to have low or no detectable infectivity (Brown 1994, Brown 1996, Rutala 2002 draft). 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 (Carp 1982, Ingrosso 1999). These animal models and experimental designs may not be directly applicable to human transmission and clinical dentistry, but they suggest a theoretical risk of transmitting prion diseases through oral tissues.

Epidemiological investigation has not revealed any evidence that dental procedures increase the risk of iatrogenic transmission of TSEs among humans. There are no published reports of CJD transmission associated with dental procedures (e.g., root canals, extractions), of DHCP occupationally infected with CJD, or convincing evidence of prions detected in human blood, saliva, or oral tissues (Kondo 1982, Van Duijn 1998, Collins 1999). In 2000, prions were not detected in the dental pulps of eight patients with neuropathologically confirmed sporadic CJD in an analysis that used electrophoresis and a Western blot technique (Blanquet-Grossard 2000).

Prions exhibit unusual resistance to conventional chemical and physical decontamination procedures. Considering this resistance and the invariably fatal outcome of CJD, the procedures for disinfecting and sterilizing instruments potentially contaminated with the CJD prion have been both conservative and controversial for many years. Yet, based on the long history and low prevalence of sporadic CJD in the U.S., available scientific data, and current epidemiology, the risk, if any, of sporadic CJD transmission during dental and oral surgical procedures is very low.

Until additional scientific information is available regarding the transmissibility of CJD or vCJD, special precautions may be indicated when treating the known CJD or vCJD patient; a list of such precautions is provided for consideration without recommendation (Favero Asia 1998, Favero 2001, Rutala 1996, World Health Organization 1999).

- Use single-use disposable items and equipment whenever possible.

- Consider items difficult to clean (e.g., endodontic files, broaches, carbide and diamond burs) as single-use disposable and discard after one use.
- To minimize drying of tissues and body fluids on a device, keep the instrument moist until cleaned and decontaminated.
- Use personal protective equipment when cleaning and disinfecting environmental surfaces.
- Those items constructed so that cleaning procedures result in effective tissue removal can be cleaned by immersing in 1N NaOH for 1 hour, rinsing in water, and sterilizing by autoclaving for 1 hour at 134ºC in a prevacuum sterilizer or at 121ºC in a gravity displacement sterilizer.
- Do not use flash sterilization for reprocessing instruments or devices.

The CDC maintains an active surveillance program on CJD; as additional scientific information becomes available, it can be accessed at http://www.cdc.gov/ncidod/diseases/cjd/cjd.htm.

Personal Protective Equipment

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 infectious or potentially infectious materials. The primary barrier equipment used in oral health care settings includes gloves, masks, protective eyewear, face shields, and protective apparel (e.g., gowns, jackets). All personal protective equipment must be removed before DHCP leave patient-care areas (OSHA 1991). Reusable PPE (e.g, protective eyewear, face shield) should be cleaned and disinfected between patients (CDC 1993, OSHA 1991). The wearing of gloves, masks, protective eyewear, and protective apparel in specified circumstances to reduce the risk of exposures to bloodborne pathogens is mandated by the OSHA bloodborne pathogens final rule (OSHA 1991). General work clothes (e.g., uniforms, pants, shirts) not intended to protect against a hazard are not considered personal protective equipment.

Masks, Protective Eyewear, Face Shields

A surgical mask that covers both the nose and the mouth, and protective eyewear with solid side shields should be worn by DHCP during procedures and patient care activities that are likely to generate splashes or sprays of blood or body fluids. A surgical mask protects DHCP against exposure to large-particle droplet spatter (larger than 5um) that may contain bloodborne pathogens or other infectious microorganisms. Droplets are transmitted by close contact and generally travel short distances (up to 3 feet). If a surgical mask becomes wet, it should be changed between patients or during patient treatment (CDC 1993, OSHA 1991). Surgical masks are not designed to provide adequate protection of DHCP against exposure to airborne microorganisms or droplet nuclei less than 5um (e.g., *M. tuberculosis*). In these situations, personal respiratory protection using particulate respirators (e.g., N-95 respirator) would be necessary for adequate protection. Protective eyewear and a surgical mask are adequate for procedures where small amounts of spatter or splashes are likely. Adding a face shield may be useful when more protection is desired.

Protective Apparel

Various types of protective apparel should be worn to prevent contamination of clothing and to protect the skin of personnel from blood and body fluid exposures (OSHA 1991, Garner 1996, Mangram 1999, CDC 1987, CDC 1988). The OSHA bloodborne pathogens final rule mandates that the sleeves should be long when the gown is worn as personal protective equipment (e.g., when spatter and spray of blood, saliva, or other potentially infectious material is anticipated) (OSHA 1991). Protective apparel should be changed if visibly soiled (Mangram 1999) and should be changed immediately or as soon as feasible if penetrated by blood or other potentially infectious fluids (OSHA 1991). All protective apparel shall be removed prior to leaving the work area (OSHA 1991).

Gloves and Gloving

Medical gloves—both patient examination and surgical gloves—are manufactured as single-use disposable items that should be used for only one patient, then discarded. Gloves must be changed between patients or when torn. DHCP wear gloves to provide a protective barrier and to prevent contamination of their hands when touching mucous membranes, blood, saliva, or other potentially infectious materials. In addition, gloves reduce the likelihood that microorganisms present on the hands of DHCP will be transmitted to patients during invasive or other patient care procedures (CDC 1986, CDC 1987, CDC 1988, CDC 1993).

Wearing gloves does not replace the need for handwashing. Hand hygiene should be performed immediately prior to donning gloves. Gloves may have small, inapparent defects or may be torn during use, and hands can become contaminated during their removal (DeGroot-Kosolcharoen 1989, Korniewicz 1989, Kotilainen 1989, Olsen 1993, Larson 1995, Murray 2001, Burke 1996, Burke 1990, Nikawa 1994, Nikawa 1996, Otis 1989). 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 immediately after glove removal.

Types of Gloves

Because gloves are task specific, their selection and fit must be based on the type of procedure to be performed (e.g., surgical, patient examination) (Table 2). Sterile surgical gloves must meet standards for sterility assurance established by the FDA and are more likely than patient examination gloves to harbor pathogens that could contaminate an operative wound.

838 **Table 2. Types of Gloves**

Glove Type	Indications	Comments	Commercially Available Glove Materials*	
			Materials	Comments††
Patient examination gloves†	Patient care, examinations, and other nonsurgical procedures involving contact with mucous membranes	Medical device regulated by the FDA should be labeled as a medical or dental glove Nonsterile and sterile single-use disposable. Use for one patient and discard appropriately	-Natural-rubber latex (NRL) -Nitrile -Nitrile & chloroprene (Neoprene) blends -Nitrile & NRL blends -Butadiene methyl methacrylate -Polyvinyl chloride (PVC, vinyl) -Polyurethane -Styrene-based copolymer	1, 2 2, 3 2, 3 1, 2, 3 2, 3 4 4 4, 5
Surgical gloves†	Surgical procedures	Medical device regulated by the FDA should be labeled as a medical or dental glove Sterile and single-use disposable. Use for one patient and discard appropriately Orthopedic surgical gloves may be thicker and more resistant to tear than other surgical gloves.	-NRL -Nitrile -Chloroprene (Neoprene) -NRL & nitrile or chloroprene blends -Synthetic polyisoprene -Styrene-based copolymer -Polyurethane	1, 2 2, 3 2, 3 2, 3 2 4, 5 4
Non-medical gloves	Housekeeping procedures (e.g., cleaning and disinfection) Handling contaminated sharps or chemicals Do not use during patient care	Not a medical device regulated by the FDA Commonly referred to as utility, industrial, or general purpose gloves and should be puncture-and chemical resistant. Latex gloves do not provide adequate chemical protection Sanitize after use	-NRL & nitrile or chloroprene blends -Chloroprene (Neoprene) -Nitrile -Butyl rubber -Fluoroelastomer -Polyethylene and ethylene vinyl alcohol copolymer	2, 3 2, 3 2, 3 2, 3 3, 4, 6 3, 4, 6

839 * Physical properties can vary by material, manufacturer, and protein and chemical composition.
840 † Medical or dental patient examination gloves and surgical gloves are medical devices regulated by the FDA. Only FDA cleared medical or dental patient
841 examination gloves and surgical gloves can be used for patient care.
842 †† Material: 1–contains allergenic NRL proteins; 2–vulcanized rubber, contains allergenic rubber processing chemicals; 3–likely to have enhanced chemical
843 and/or puncture resistance; 4)–nonvulcanized and does not contain rubber processing chemicals; 5)–inappropriate for use with methacrylates; and 6)–resistant to
844 most methacrylates.

Glove Integrity

Limited studies of the penetrability of various glove materials under conditions of use have been conducted in the dental environment. Consistent with observations in clinical medicine, leakage rates have varied by glove material (e.g., latex, vinyl, nitrile), duration of use, and type of procedure performed (Morgan 1989, Otis 1989, Burke 1990, Albin 1992, Merchant 1992, Nikawa 1996). The frequency of perforations in surgical gloves used during outpatient oral surgical procedures has ranged from 6% to16% (Avery 1998, Burke 1996, Schwimmer 1994, Patton 1995).

The FDA regulates the medical glove industry, which includes gloves marketed as sterile surgical 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 surgical than to examination gloves. The FDA has identified failure rates for glove manufacturers (Food and Drug Administration 1990), but gloves eventually fail with exposure to mechanical (e.g., sharps, fingernails, 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) properly using engineering and work practice controls to avoid injuries with sharps.

Studies have shown that medical and DHCP are frequently unaware of small tears in gloves that occur during use and thus for enhanced protection it may be good to change gloves during a long procedure (Merchant 1992, Albin 1992, Otis 1989, Gerberding 1990). These four studies found that gloves developed defects over 30 minutes to 3 hours depending upon glove and procedure type. There was no consensus on the optimal time for changing gloves during procedures.

Examination and surgical gloves commonly contact many types of chemicals and materials (e.g., disinfectants and antiseptics, composite resins, bonding agents) during dental procedures that may compromise the integrity of latex as well as vinyl, nitrile, and other synthetic glove materials (Klein 1990, Mellstrom 1992, Jordon 1996, Cappuccio 1997, Monticello 1999, Baumann 2000, Ready 1989, Richards 1993, Andersson 1999). In addition, latex gloves can compromise the setting of vinyl polysiloxane impression materials (Reitz 1988, Kahn 1989, Matis 1997), although it appears that the setting is not adversely affected by synthetic vinyl gloves (Reitz 1988, Kahn 1989). Given the diverse selection of dental materials on the market, dental facilities should consult with the glove manufacturer about the chemical compatibility of glove material.

If the integrity of a glove is compromised (e.g., punctured), it should be changed as promptly as safety permits (OSHA 1991, Wright 1991, Dodds 1988). Washing latex gloves with plain soap, chlorhexidine, or alcohol can lead to the formation of glove micropunctures (Adams 1992, Martin 1988, DeGroot-Kosolcharoen 1989) and hand contamination (Doebbeling 1988). Because this condition, known as "wicking," may allow penetration of liquids through undetected holes in the gloves, washing gloves is not recommended. After a hand rub with alcohol, the hands must be thoroughly dried before gloving, because hands still wet with an alcohol-based hand hygiene product may increase the risk of glove perforation (Pitten 2000).

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 contact dermatitis or allergic contact dermatitis. Irritant contact dermatitis, is very common and develops as dry, itchy, irritated areas on the skin around the area of contact. Irritant contact dermatitis is not due to an allergy. By comparison, allergic contact dermatitis (type IV hypersensitivity) may result from exposure to accelerators and other chemicals used in the manufacture of rubber gloves (e.g., natural rubber latex, nitrile, neoprene), and other chemicals found in the dental office (e.g., methacrylates, glutaraldehyde). Allergic contact dermatitis often manifests as a rash beginning several hours after contact and like irritant dermatitis, is usually confined to the area of contact.

Latex allergy (type I hypersensitivity to latex proteins) can be a more serious whole-body allergic reaction; here, reactions usually begin within minutes of exposure but can occur hours later and may produce varied symptoms. More common reactions include skin, nose, and eye symptoms such as 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 symptoms, and in rare cases, anaphylaxis and death (CDC/NIOSH 1997, Dillard 2002).

Natural rubber latex proteins responsible for latex allergy have been shown to attach 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, where they can be inhaled and contact mucous membranes (Heilman 1996). As a result, allergic DHCP can experience cutaneous, respiratory, and conjunctival symptoms related to latex protein exposure. Other DHCP may become sensitized to latex protein with repeated exposure (Baur 1990, Turjanmaa 1990, Baur 1998, Trape 2000, Allmers 1998). In contrast, work areas where only powder-free low-allergen latex gloves are used, show low or undetectable amounts of the latex allergy-causing proteins (Tarlo 1994, Swanson 1994, Hermesch 1999) and healthcare workers have lower levels of symptoms related to natural rubber latex allergy. Because of the increasing role of glove powder in exposure to latex protein, the National Institute for Occupational Safety and Health (NIOSH) recommends that if latex gloves are chosen, the health-care facility provide personnel with reduced-protein, powder-free gloves (NIOSH 1997). Non-latex, powder-free, and low-protein gloves are available to help address these situations (ADA 1999, Miller Therapeutics 2000). While rare, potentially life-threatening anaphylactic reactions to latex can occur; dental facilities should be appropriately equipped and have procedures in place to handle 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 (NIOSH 1997). Individuals may also be allergic to the chemicals used in the manufacturing of natural rubber latex and synthetic rubber gloves as well as to metals, plastics, or other materials used in dental care. A thorough health history and appropriate avoidance of contact with potential allergens will minimize the possibility of adverse reactions. Among the considerations in providing safe treatment for patients with possible or documented latex allergy are the following:

- Screen all patients for latex allergy (e.g., health history, medical consultation when latex allergy is suspected)
- Be aware of some common predisposing conditions (e.g., previous history of allergies, a history of spina bifida, urogenital anomalies, or allergies to avocados, kiwis, nuts, or bananas)
- Be familiar with the different types of hypersensitivity–immediate and delayed–and the risks they pose for patient and staff
- Consider sources of latex other than gloves. Dental patients with histories of latex allergy may be at risk from a variety of dental products, such as prophylaxis cups, rubber dams, orthodontic elastics, anesthetic carpule stoppers, and medication vials
- Ensure a latex-safe environment, one in which no DHCP wears latex gloves and no patient has contact with other latex devices, materials, or products
- Remove all latex-containing products from the patient's vicinity. Adequately cover/isolate any latex-containing devices that cannot be removed from the treatment environment
- Be aware that latent allergens in the ambient air can cause respiratory or anaphylactic symptoms in people with latex hypersensitivity. It may be advisable to schedule patients with latex allergy for the first appointment of the day to minimize their inadvertent exposure to airborne latex particles. Frequently clean all working areas contaminated with latex powder/dust
- Frequently change ventilation filters and vacuum bags used in latex-contaminated areas
- Have latex-free kits (e.g., dental treatment and emergency) available at all times
- Be aware that allergic reactions can be provoked from indirect contact as well as direct contact (e.g., being touched by someone who has worn latex gloves). Hand hygiene, therefore, is essential
- Communicate with other personnel about latex allergy (e.g., by verbal instructions, written protocols, posted signage) to prevent them from bringing latex-containing materials into the treatment area
- 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 (NIOSH 1997).

Hand Hygiene

Hand hygiene (e.g., handwashing, hand antisepsis, or surgical hand antisepsis) significantly reduces potential pathogens on the hands and is considered the single most important measure to reduce the risk of transmitting organisms to patients and HCP (Steere 1975, Garner Supercedes 1986, Larson 1995, CDC Hand 2002). Hospital-based studies have shown that noncompliance with hand hygiene practices is associated with health-care-associated infections and the spread of multiresistant organisms and has been a major contributor to outbreaks (CDC Hand 2002). Studies also have shown that the prevalence of health-care-associated infections decreases as adherence of HCP to recommended hand hygiene measures improves (Casewell 1977, Larson 2000, Pittet 2000).

The microbial flora of the skin, first described in 1938, consist of resident and transient microorganisms (Price 1938). Transient flora, which colonize the superficial layers of the skin,

are more amenable to removal by routine handwashing. They are often acquired by HCP during direct contact with patients or contaminated environmental surfaces, and they are the organisms 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 anticipated degree of contamination, and the desired persistence of antimicrobial action on the skin (Table 3). Thus, for such routine dental care as examinations and non surgical procedures, either plain soap and water or an antiseptic agent (e.g., antimicrobial soap or 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, should gloves become punctured or torn, so as to prevent the introduction of organisms in the operative wound. Skin bacteria can rapidly multiply under surgical gloves if hands are washed with soap that is not antimicrobial (Price 1938, Dewar 1973), and thus, an antiseptic with antimicrobial activity (e.g., antimicrobial soap) should be used before surgical procedures (Lowbury 1960, Rotter 1999, Widmer 2000). Agents used for surgical hand antisepsis should significantly reduce microorganisms on intact skin, contain a non-irritating antimicrobial preparation, have a broad spectrum of activity, be fast acting, and have a persistent effect (Garner Supercedes 1986, Larson 1990, Faoagali 1995, AORN 2002). Persistence (i.e., extended antimicrobial activity that prevents or inhibits the proliferation or survival of microorganisms after the product is applied) is important because microorganisms can colonize on hands in the moist environments underneath gloves (Larson 1995). Alcohol handrubs are rapidly germicidal when applied to the skin but must include the addition of chlorhexidine, quaternary ammonium compounds, octenidine, or triclosan to achieve persistent activity (Rotter 1999). In addition to the choice of antiseptic agent, factors that may influence the effectiveness of the surgical scrub include technique and duration as well as condition of the hands and the techniques used for drying and gloving.

1012 **Table 3. Hand Hygiene**

Methods	**Agent**	**Purpose**	**Area**	**Duration (minimum)**	**Indications** (OSHA 1991, CDC Universal Precautions 1988, CDC HIV 1987, Garner SSI and Hand 1986, Larson 1995, Steere 1995, Larson 2000, Pittet 2000, CDC Hand 2002, Garner 1996, Mangram 1999, Doebbeling 1988)
Routine handwash	Water and non-antimicrobial detergent (e.g., plain soap*)	Remove soil and transient microorganisms	Fingertips to the wrist	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 • when visibly soiled § • before regloving after removing gloves that are torn, cut, or punctured
Routine hand antisepsis Antiseptic handwash or Antiseptic hand rub	Water and antimicrobial agent/detergent (e.g., chlorhexidine, iodine and iodophors, chloroxylenol [PCMX], triclosan) Alcohol-based hand rub§	Remove or destroy transient microorganisms and reduce resident flora	Fingertips to the wrist at a minimum	15 seconds† Rub hands until the agent is dry§	
Surgical hand antisepsis	Water and antimicrobial agent/detergent (e.g., chlorhexidine, iodine and iodophors, chloroxylenol [PCMX], triclosan) Water and non-antimicrobial detergent (e.g., plain soap*) followed by an alcohol-based hand rub with persistent activity	Remove or destroy transient microorganisms and reduce resident flora (persistent effect)	Hands and forearms up to the elbows¶	2-6 minutes Follow manufacturer instructions for alcohol-based hand rub§ ¶ ¶	• before donning sterile, surgical gloves for surgical procedures

1013 * Pathogenic organisms have been found on or around bar soap during and after use (Kabara 1984). Use of liquid soap with hands-free dispensing controls is
1014 preferable.

† Washing times of 10-15 seconds have been reported as effective in removing most transient flora from the skin. For most procedures, a vigorous, brief (at least 15 seconds) rubbing together of all surfaces of premoistened lathered hands and fingers followed by rinsing under a stream of cool or tepid water is recommended (Steere 1975, Ojajärvi 1981, Garner 1985, Larson 1986, Ayliffe 1992, CDC Hand 2002). Hands should always be dried thoroughly before donning gloves.

§ 60-95% ethanol or isopropanol. Alcohol-based hand rubs 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 hands 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 (CDC Hand 2002).

¶ Removal of all jewelry, washing as described in the second footnote (†) holding the hands above the elbows during final rinsing, and drying the hands with sterile towels (Mangram 1999, Larson 1995, CDC Hand 2002, AORN 2002).

¶¶ After application of the alcohol-based product as recommended, allow hands and forearms to dry thoroughly and immediately don sterile gloves (Hobson 1998, Mulberry 2001).

Selection of Antiseptic Agents

Selecting the most appropriate antiseptic agent for hand hygiene requires consideration of several factors. Essential performance characteristics of a product, such as 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 personnel acceptance is a major factor in compliance with recommended hand hygiene protocols (Larson 1982, Zimakoff 1992, CDC Hand 2002, Larson 1995), it is important to consider personnel needs including possible chemical allergies, skin integrity after repeated use, compatibility with any lotions used, and offensive agent ingredients (e.g., scent).

Storage and Dispensing of Hand Care Products

Handwashing products, including plain (not antimicrobial) soap and antiseptic products, can become contaminated or support the growth of microorganisms (Larson 1995). 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, as this practice of "topping off" may lead to bacterial contamination of the soap (Grohskopf 2001, Archibald 1997) and negate the beneficial effect of hand cleaning and disinfection.

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 (Larson 1998 AJIC, Ojajärvi 1977). The potential of detergents to cause skin irritation varies considerably, but it can be reduced by adding emollients. Lotions are often recommended to ease the dryness resulting from frequent handwashing and more recently to prevent dermatitis from glove use (Berndt 2000, McCormick 2000). Petroleum-based lotion formulations, however, can weaken latex gloves and increase permeability. For that reason, use of lotions that contain petroleum or other oil emollients should not accompany gloving (MMWR 1993, Garner Supercedes 1986, OSHA 2001 CPL, Larson 1993, Larson 1995) though could be used at the end of the work day. At the time of product selection, dental facilities should obtain information from the manufacturer regarding interaction between lotions, gloves, and antimicrobial products.

Fingernails and Artificial Nails

Although the relationship between fingernail length and wound infection is unknown, keeping the nails short is considered important because most flora on the hands are found under and around the fingernails (McGinley 1988). Nails should be short enough to allow DHCP to thoroughly clean underneath them and to prevent glove tears (Larson 1995). Sharp nail edges or broken short nails are also likely to increase glove failure. Long artificial or natural nails can make donning gloves more difficult and may cause gloves to tear more readily. Hand carriage of gram-negative organisms has been shown to be greater among wearers of artificial nails than among non wearers, both before and after handwashing (Pottinger 1989, McNeil 2001, Rubin 1988, Hedderwick 2000). In addition, artificial fingernails or extenders have been epidemiologically implicated in several outbreaks in hospital intensive care units and operating rooms involving fungal and bacterial infections (Passaro 1997, Foca 2000, Parry 2001,

Moolenaar 2000). Freshly applied nail polish on natural nails does not increase the microbial load from periungual skin as long as fingernails are short, however, chipped nail polish may harbor more bacteria (Baumgardner 1993, Wynd 1994).

Jewelry

Although total bacterial counts are higher on the skin underneath rings than on comparable areas of skin on fingers without rings, rings do not interfere with removal of bacteria by handwashing (Jacobson 1985). Whether wearing rings increases the likelihood of transmitting a pathogen is not known. Rings and decorative nail jewelry can make donning gloves more difficult, and they may cause gloves to tear more readily (Larson 1989, Field 1996). Thus, jewelry must not interfere with glove usage (e.g., ability to wear the correct-size glove, alter glove integrity). Before surgical hand antisepsis, all jewelry (e.g., rings, watch, bracelet) should be removed and kept off until the surgical procedure is complete (Mangram 1999).

Sterilization or Disinfection of Patient Care Items

Patient care items (dental instruments, devices, and equipment) can be categorized as critical, semicritical, or non critical based on the potential risk of infection based on their use. (Table 4) (Spaulding 1968). Critical items used to penetrate soft tissue or bone have the highest risk of transmitting infection and should be sterilized by heat. Semicritical items touch only mucous membranes and have a lower risk of transmission, but because most semicritical items are heat tolerant, they should be sterilized using heat. If a semicritical item is heat sensitive, it must, at a minimum, be treated with high-level disinfection (CDC 1993). Noncritical patient care instruments and equipment (e.g., blood pressure cuff, stethoscope, pulse oximeter) contact only intact skin, which can serve as an effective barrier to microorganisms. Noncritical items pose the least risk of transmission of infection. In most cases, cleaning followed by low-level disinfection is appropriate for noncritical patient care items. If the item is visibly contaminated with blood, it should be cleaned and disinfected with a tuberculocidal (i.e., intermediate-level) disinfectant before use on another patient (CDC 1993, Rutala 2002).

Table 4. Categories of Patient-Care Items

Category	Definition	Examples
Critical	Penetrate soft tissue, contact bone, enter into or contact the bloodstream, or other normally sterile tissue of the mouth	Surgical instruments, scalers, scalpel blades, surgical dental burs
Semicritical	Contact mucous membranes, but will not penetrate soft tissue, contact bone, enter into or contact the bloodstream, or other normally sterile tissue of the mouth	Dental mouth mirror, amalgam condenser, reusable dental impression trays**,** dental handpieces*
Noncritical	Contact with intact skin	Blood pressure cuff, stethescope, pulse oximeter

*Although dental handpieces are considered a semicritical item, heat sterilization is recommended (FDA handpiece letter 1992). See section entitled Dental Handpieces and Other Devices Attached to Air or Waterlines for detailed processing information.

The three levels of disinfection (high, intermediate, and low) are used for devices and surfaces that do not require sterility (Spaulding 1968); the intended use for patient care will determine the necessary level of decontamination. Dental facilities should closely follow the product manufacturer's directions regarding concentrations and exposure time for appropriate disinfectant activity. A summary of sterilization and disinfection methods is included in Appendix 4.

Critical and Semicritical Patient Care Items

Instrument processing requires multiple steps to achieve sterilization or high-level disinfection. Sterilization is a complex process requiring specialized, properly functioning equipment adequate space, qualified personnel who are provided with ongoing training, and continuous monitoring for quality assurance (AAMI 2002). Proper cleaning, packaging, sterilizer loading

procedures, sterilization methods, and high-level disinfection methods should be followed to ensure the final product is properly processed and safe for reuse.

DHCP may be exposed to microorganisms on contaminated instruments and devices through percutaneous injury, non-intact skin on the hands, or contact with mucous membranes of the eyes, nose, or mouth. Contaminated instruments must be handled carefully to prevent exposure to sharp instruments that could cause a percutaneous injury. To reduce the amount of handling and the risk for exposure of DHCP, individual instruments or perforated cassette trays should be placed in a solid, rigid, covered transport tray at the point of use and the tray carried to the processing area.

Instrument Processing Area

Dental health-care personnel should process all instruments in a designated central processing area to more easily control quality and ensure personnel safety (AAMI 1998). The instrument processing area should be divided into work areas for: 1) receiving, cleaning, and decontamination; 2) preparation and packaging; 3) sterilization; and 4) storage. Walls or partitions should ideally separate work areas to control traffic flow and contain contaminants generated during processing. When physical separation of these areas cannot be achieved, adequate spatial separation may be satisfactory if the personnel who process instruments are trained in appropriate work practices to prevent contamination of clean areas (AAMI 1998). Consider the needs of the dental office in determining the size of the processing areas. Space should be provided according to the volume of work anticipated and the volume of items to be stored (AAMI 2002).

Receiving, Cleaning, and Decontamination Work Area

In this area, reusable instruments, supplies, and equipment are received, sorted, cleaned and decontaminated. Cleaning precedes all disinfection and sterilization processes and involves the removal of debris and organic contamination from an instrument, device, or surface. Removal of debris and contamination is usually achieved using either the physical action of scrubbing along with a surfactant or detergent/water or by an automated process (e.g., ultrasonic cleaner, washer-disinfector) with appropriate chemical agents. If visible debris or organic matter is not removed it will interfere with microbial inactivation and may compromise the disinfection or sterilization process (Favero 2001, Parker 1995, Alfa 1998, Rutala 1998, Sehulster 2002). Following cleaning, instruments should be rinsed with water to remove chemical or detergent residue. Splashing should be minimized during rinsing and cleaning (OSHA 1991).

Considerations in selecting cleaning methods and equipment include the efficacy of the method, process, and equipment; compatibility with the items to be cleaned; and occupational health and exposure risks. Automated cleaning equipment (e.g., ultrasonic cleaner, washer-disinfector) does not require preprocessing of instruments and may increase productivity, improve cleaning effectiveness, and decrease worker exposure to blood and body fluids. Accordingly, using automated equipment may be more efficient and safer than manually cleaning contaminated instruments (Miller 2000).

If manual cleaning is necessary, placing instruments in a container and soaking them with a disinfectant/detergent or an enzymatic cleaner will prevent drying of patient material and make

manual cleaning easier and less time-consuming. Using work practice controls (e.g., long-handled brush) to keep the scrubbing hand as far as possible from sharp instruments is recommended (OSHA CPL 2001). To avoid injury from sharp instruments, personnel should wear puncture-resistant, heavy-duty utility gloves when handling or manually cleaning contaminated instruments and devices (CDC 1988). If splashing is likely to occur, a face mask, eye protection or face shield, and gown or jacket should be worn (OSHA 1991).

Instruments should be considered contaminated and handled as such until processed through the sterilization cycle unless the instrument has been processed with an automated instrument washer with high-level disinfection cycle. Employees must not reach into trays or containers holding sharp instruments (OSHA 1991). To reduce the risk of injury, instruments could be picked-up using forceps or their contents emptied onto a towel.

Preparation and Packaging

Cleaned or decontaminated instruments and other dental supplies are inspected, assembled into sets or trays, and wrapped, packaged, or placed into container systems for sterilization in this area. Critical and semicritical instruments that will not be used immediately should be wrapped or placed in rigid containers before sterilization (CDC 1993, Ninemeier 1998, AAMI 1993,1996,1999, Rutala 2000). Materials for maintaining the sterility of instruments during transport and storage include wrapped perforated instrument cassettes, peel pouches of plastic and/or paper, and sterilization wraps (woven and nonwoven). The packaging material must allow penetration of the sterilization agent and maintain the sterility of the processed item after sterilization. Packaging materials must be compatible with the instrument and designed for the type of sterilization process being used (AAMI 1993,1996,1999, Rutala 2000).

Sterilization Area

The sterilization area contains the sterilizers and related supplies. There should be adequate space for loading, unloading, and cool-down. This area may also include incubators for analyzing spore tests and enclosed storage for sterile items and disposable (single-use) items (Miller 1998).

Sterilization Procedures

Heat-tolerant dental instruments are generally sterilized by one of the following methods: 1) steam under pressure (autoclaving); 2) dry heat; 3) unsaturated chemical vapor. All sterilization should be performed in medical sterilization equipment cleared by the FDA. Items to be sterilized should be arranged to allow for free circulation of the sterilizing agent (e.g., steam, chemical vapor, dry heat) around each one. The manufacturer's instructions for loading the sterilizer to allow proper circulation of the sterilizing agent must be followed (Miller 1998, AAMI 1998). The ability of equipment to achieve the physical parameters necessary to achieve sterilization should be monitored by mechanical, chemical, and biological indicators. Examples of recognized exposure periods for sterilization methods used in dentistry are summarized in Table 5.

Table 5. Examples of Sterilization Times and Temperatures for Packaged Items*

Method†	Time§ (minutes)	Temperature ºC (ºF)	Biologic Monitoring
Steam autoclave			*Bacillus stearothermophilus*
• Gravity displacement	30	121 (250)	
• Pre-vacuum sterilizer	4	132 (270)	
Dry Heat			*Bacillus subtilis*
• Static air	60	170 (340)	
	120	160 (320)	
	150	150 (300)	
• Forced air	12	190 (375)	
Unsaturated chemical vapor	20	132 (270)	*Bacillus stearothermophilus*

* Some parameters may vary slightly by manufacturer.

† All sterilization equipment should be cleared by the FDA.

§ Does not include warm-up, cooling, and drying time. To avoid contamination, packages should be allowed to dry in the sterilizer before they are handled.

Modified from Miller CH, Palenik CJ, eds. Infection control and management of hazardous materials for the dental team, 2nd ed. 1998. St. Louis, Mosby.

Steam Sterilization

Of all the methods available for sterilization, steam sterilization, which is very dependable, is the most widely used for critical and semicritical items that are not sensitive to heat and moisture (Miller 2001). Steam sterilization requires exposure of each item to direct steam contact at the required temperature and pressure for the specified time. Pressure serves as the means to obtain the high temperatures needed to quickly kill microorganisms. Most dental practices use table-top gravity displacement sterilizers, although pre-vacuum sterilizers are becoming more widely available.

Flash Steam Sterilization

"Flash" or "fast" steam sterilization is a process for steam sterilizing patient care items for immediate use (AAMI 1996). A flash sterilization cycle operates at higher temperatures for shorter times and is preprogrammed to a specific time and temperature setting established by the manufacturer based on the type of sterilizer control (e.g., gravity displacement, pre-vacuum). To permit immediate contact with the steam in this short cycle, the instrument is typically unwrapped. Flash sterilization of instruments should be used only in carefully selected clinical situations (e.g., an urgent need to sterilize a particular instrument inadvertently contaminated) and when certain conditions are met: 1) thorough cleaning and drying of an instrument must precede any flash sterilization cycle; 2) all parameters, including mechanical, chemical, and biological monitors for each cycle, must be documented; and 3) flash-sterilized items must be transported immediately to the point of use so that the sterility is maintained (AORN 2002, AAMI 1996, Vesley 1992, Rutala 1993, Hood 1997, Rutala 1999). In most circumstances, the

need to "flash" sterilize instruments can be prevented by efficient management of instrument inventory. Use of flash sterilization for implantable devices is not practical, as they must be quarantined and await the outcome of the biological monitoring before patient use (AORN 2002).

Dry-Heat Sterilization

Dry heat is used to sterilize materials that might be damaged by moist heat. Although dry heat has the advantages of having a low operating cost and being non-corrosive, it is a prolonged process and the high temperatures needed are not suitable for some patient care items and devices (Joslyn 2001).

Dry-heat sterilizers used in dentistry that have been cleared by the FDA include the static-air and the forced-air types:

1. The static-air type is commonly called an oven-type sterilizer. Heating coils in the bottom or sides of the unit cause the hot air to rise inside the chamber through natural convection.
2. 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 a more rapid transfer of energy from the air to the instruments, thereby reducing the time needed for sterilization.

Unsaturated Chemical-Vapor Sterilization

Unsaturated chemical vapor sterilization involves heating a chemical solution (0.23% formaldehyde; 72.38% ethanol plus acetone, ketone, water and other alcohols) in a closed chamber. Although unsaturated chemical vapor sterilization of carbon steel instruments (e.g., dental burs) causes less corrosion than steam sterilization, it has disadvantages as well. State and local authorities should be consulted for hazardous waste disposal requirements for formaldehyde. Personnel should wear appropriate protective equipment to protect their skin and eyes from contact with the solution and should not breathe its vapors. Adequate room ventilation is required.

Low-Temperature Sterilization

Ethylene oxide gas (ETO) has been used extensively in many larger health-care facilities as a low-temperature sterilant. Its primary advantage is that it can sterilize heat- and moisture-sensitive patient care items without deleterious effects. Extended sterilization times of 10–48 hours depending on the material and stringent standards for ETO emissions may make it impractical to use this method in private practice settings. Handpieces cannot be effectively sterilized with this method due to decreased penetration of ETO gas flow through a small lumen (Pratt 1999, Parker 1995). Other types of low temperature sterilization (e.g., hydrogen peroxide gas plasma) exist but they have not been applied to dentistry or are not yet practical for dental offices.

"Bead Sterilizer"

"Bead sterilizers" which provide inconsistent heating and significant temperature variation, are not acceptable. The FDA has found a risk of infection with these devices because of their potential failure to sterilize dental instruments and has required that their commercial distribution cease unless the manufacturer files a premarket approval application. If a "bead sterilizer" is

employed, the user is assuming the risk of using a dental device that the FDA has deemed not to be safe and effective (FDA 1997).

Heat-Sensitive Instruments and Devices and Liquid Chemical Sterilants

Heat-sensitive critical and semicritical instruments and devices can be sterilized or high-level disinfected using low-temperature sterilization (e.g., ethylene oxide, hydrogen peroxide gas plasma) or by liquid chemical germicides registered by the FDA as a "sterilant" (i.e., sterilant/high-level disinfectant). Chemical sterilants may place health-care workers at risk and require special room ventilation. In addition, the process cannot be verified with biological indicators (Bond 1993). The use of heat-sensitive items (e.g., x-ray positioning ring, some bite blocks, plastic rulers, plastic resin applicators) requiring liquid chemical sterilization or high-level disinfection is discouraged, with heat-tolerant or disposable instruments and devices preferred. In addition, chemical sterilants should not be used on noncritical patient care items or on environmental surfaces. Sterilizing instruments using chemical sterilants may require up to 12 hours of complete immersion; shorter immersion times are used to achieve high-level disinfection. Items intended to be sterilized need to be rinsed with sterile water to maintain sterility and to remove toxic or irritating residues. Subsequently, the objects need to be handled and dried with sterile gloves and towels and delivered to the use area in an aseptic manner to maintain sterility. If the instrument is intended to be stored, it should not be considered sterile. If liquid chemical sterilants must be used, manufacturer instructions for the use of chemical sterilants should be followed closely (e.g., room exhaust ventilation, 10 air exchanges per hour, closed containers) (AAMI 1996, CDC NIOSH 2001) to ensure the effectiveness of the process and the safety of DHCP. For example, although glutaraldehyde-based products can be used without tissue irritation or adverse health effects, dermatologic, eye irritation, and respiratory effects on overexposed personnel have been reported, and skin sensitization in some individuals. Adequate precautions (e.g., chemically-resistant gloves and aprons, goggles, face shields) should be taken (Ballantyne 1995, CDC NIOSH 2001).

Barrier Protected Semicritical Instruments

Electronic or other high-technology semicritical instruments (e.g., digital radiography sensors, lasers, intraoral camera, electronic periodontal probe, occlusal analyzers) vary in their ability to be sterilized or high-level disinfected. Items that can not be reprocessed by immersion or sterilization techniques should be barrier protected during use using an FDA-cleared barrier. Use of a barrier, however, does not always protect the item from contamination. Studies have examined the perforation rate of commercially-available barriers applied to ultrasound probes and found high rates of perforation, and in one study, even before clinical use (Hignett 1995). Barrier-protected, medical probes failed at a higher rate than condom barriers, though both showed some degree of failure (Fritz 1993, Milki 1998, Storment 1997, Amis 2000, Rooks 1996, Odwin 1990). Another study, indicated that one brand of commercially-available plastic barriers used to protect digital radiography sensors failed at a significant rate (44%). This rate dropped to 6% when latex finger cots were used in conjunction with the plastic barrier (Hokett 2000). Since the use of barrier protection does not eliminate the possibility of contamination, barrier protected semicritical items should be cleaned and high-level disinfected or sterilized between patients. The barrier does not change the classification of the device and the required level of disinfection or sterilization (Rutala 2002). Consult with the manufacturer for proper disinfection and sterilization methods.

Sterilization Monitoring

Monitoring of sterilization procedures should routinely include a combination of process parameters: mechanical, chemical, and biological (Favero 1998). These parameters evaluate the sterilizing conditions and the effectiveness of the procedure.

Mechanical techniques for monitoring sterilization include the daily assessment of cycle time and temperature by examining the temperature record chart, computer printout, visually observing the gauges, and assessing pressure via the pressure gauge (AAMI 1998, Rutala 2002). Incorrect readings could be the first indication that a problem with the sterilization cycle has occurred.

Chemical indicators monitor the parameters of time, temperature, and/or pressure. Single-parameter indicators can be applied to the outside of the package, placed inside the package, or be part of the packaging and will change color rapidly when a given parameter is reached (e.g., heat-sensitive tape). Single-parameter indicators are available for steam, dry heat, and unsaturated chemical vapor. Multiparameter indicators are used similarly but are currently available only for steam sterilizers. These indicators measure two or more parameters and provide a higher level of assurance that sterilization parameters have been achieved. Dental facilities should refer to the manufacturer instructions to define the use and proper placement of the chemical indicator. Indicator test results are received immediately upon completion of the sterilization cycle and could provide an early indication of a potential problem. If either the internal or external indicator suggests inadequate processing, the item should not be used (AORN 2002). Chemical indicators do not prove that sterilization has been achieved, only that parameters have been attained. A biological indicator (i.e., spore test) is required to directly measure the sterilization process.

Biological indicators are the most valid method for monitoring the sterilization process (Greene 1992, Favero 1998) because they assess the sterilization process directly by using the most resistant microorganisms (e.g., *Bacillus sp.* spores), and not by merely testing the physical and chemical conditions necessary for sterilization (Rutala 2002). Because the *Bacillus sp.* spores used in biological indicators are more resistant and present in greater numbers than are the common microbial contaminants found on patient care equipment, demonstrating that the biological indicator has been inactivated strongly implies that other potential pathogens in the load also have been killed (Maki 1987).

Proper functioning of sterilization cycles should be verified by the periodic use (at least weekly) of biological indicators (Garner 1985, CDC 1993, Greene 1992, Favero 1998, Rutala 2002, AORN 2002). Each load containing implantable devices should be monitored with such indicators (AAMI 1998). Implantable items should not be used until spore tests are known to be negative. The manufacturer's directions must be followed for appropriate placement and location of the biological indicator in the sterilizer. A control biological indicator (not processed through the sterilizer) from the same lot as the test indicator should be incubated in the same manner as the test biological indicator. The control biological indicator 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 biological indicator and the control. Although some DHCP have expressed concern that delays due to mailing specimens might cause false negatives, studies have shown that mail delays have no significant influence on final test results (Andres 1995, Miller 1994).

A procedure to follow in the event of positive spore tests has been provided by CDC and the Association of Operating Room Nurses (now the Association of Perioperative Registered Nurses) (AORN 1987): If the mechanical (e.g., time, temperature, pressure) and chemical (internal or external) indicators suggest that the sterilizer is functioning properly, a single positive spore test probably does not indicate sterilizer malfunction; items other than implantable devices do not necessarily need to be recalled. The spore test should be repeated immediately and the sterilization procedures reviewed to determine whether operator error could be responsible (Garner 1986). If the repeat spore test is positive, dental facilities should not use the sterilizer until it has been inspected or repaired or the exact reason for the positive test has been found (Garner 1986, Rutala 2002). Items from suspect load(s) should be recalled, insofar as possible, rewrapped, and resterilized (AORN 1987, Garner 1986).

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

Storage Area for Sterile and Clean Patient Care Items

The storage area contains the enclosed storage for sterile items and disposable (single-use) items (Miller 1998). Storage practices for wrapped sterilized instruments may be either date- or event-related. All packages containing sterile supplies must be inspected before use to verify barrier integrity and dryness. Although some health-care facilities continue to date every sterilized package and use the date-related shelf-life practice, many facilities have switched to event-related practice (Rutala 2002). This approach recognizes that the product should remain sterile indefinitely unless some event causes it to become contaminated (e.g., torn or wet packaging) (Mayworm 1984). Any package that has been dropped on the floor must be inspected for damage to the package or contents. If packaging is compromised, the instruments must be repackaged in new wrap and sterilized again. Dental supplies and instruments should be stored in closed or covered cabinets, if possible (Cardo 1999). Dental supplies and instruments should not be stored under sinks or in other locations where they can become wet.

Noncritical Patient Care Items

Disinfection for noncritical patient care items (e.g., blood pressure cuff, stethoscope, pulse oximeter) is discussed in Appendix 4.

Environmental Infection Control

Although surfaces in the dental operatory, including those of dental equipment, may become contaminated during patient care, these surfaces have not been associated with transmission of infection to either DHCP or patients. Environmental surfaces are all considered noncritical and can be divided into clinical contact and housekeeping surfaces (Table 6) (Favero 2001). Environmental surfaces carry the least risk of disease transmission and can be safely decontaminated using less rigorous methods than those used on dental patient care items (Sehulster 2001). Adequate safety for clinical contact and housekeeping surfaces can be achieved by cleaning and low- to intermediate-level disinfection (Appendix 4). As with non-critical patient care items, removal of all organic material and visible blood can be as important as the germicidal activity of the disinfecting agent (Favero 2001). If the surface cannot be adequately cleaned, it should be protected with barriers (CDC 1993).

Manufacturers of dental devices and equipment should provide information about material compatibility with liquid chemical germicides, whether the equipment can be safely immersed for cleaning, and how the equipment should be decontaminated if servicing is required (OSHA 1991). Because of the risks associated with exposure to chemical disinfectants and contaminated surfaces, personnel who perform environmental cleaning and disinfection should wear personal protective equipment to prevent occupational exposure to infectious agents and hazardous chemicals (OSHA 1991, OSHA 1994).

Table 6. Categories of Noncritical Environmental Surfaces

Type of Surface	Definition	Examples
Clinical Contact	Surfaces that are directly contacted by contaminated instruments, devices, hands, or gloves.	Light handles, switches, dental x-ray equipment, reusable containers of dental material, drawer handles, countertops, pencil, telephone handle, doorknob
Housekeeping	Surfaces that require regular cleaning and removal of soil and dust.	Floors, walls, sinks

Clinical Contact Surfaces

Studies have shown that HIV is rapidly inactivated on surfaces after being exposed to commonly used chemical germicides at concentrations lower than those used in practice (Spire 1984, Martin 1985, Hanson 1989, Bloomfield 1990, Druce 1995, Van Bueren 1995). Visible blood and organic material should be first removed, followed by surface disinfection (EPA List D) http://www.epa.gov/oppad001/chemregindex.htm. Low-level disinfectants registered with the Environmental Protection Agency (EPA) and labeled effective against HIV and HBV are appropriate for disinfecting clinical contact surfaces. In the absence of visible blood, complete inactivation of herpes simplex virus (which has similar susceptibilities to disinfectants as HIV) can be achieved within 30 seconds with a diluted hypochlorite solution (1:10 or 1:100), a phenolic, or a quaternary ammonium compound (Weber 1999). HBV is readily inactivated with a variety of germicides, including quaternary ammonium compounds (low-level disinfectants) (Prince 1993).

After treatment of each patient and at the completion of daily work activities, countertops and dental unit surfaces should be cleaned and disinfected using a low-level disinfectant (CDC 1993).

Barrier protection of surfaces and equipment can be particularly effective in preventing contamination of clinical contact surfaces that are difficult to clean. Effective barriers include disposable plastic wrap, plastic sheets or tubing, and plastic-backed paper or other material impervious to moisture (Crawford 1987, Miller 2001). Because such coverings may be contaminated, they should be removed and discarded while DHCP are still gloved. After removing their gloves and performing hand hygiene, DHCP should place clean covers on these surfaces before the next patient (CDC 1986, Crawford 1987, CDC 1993).

Housekeeping Surfaces

There is no evidence that HBV, HCV, or HIV has ever been transmitted from a housekeeping surface (e.g., floors, walls) in a health-care setting. Nonetheless, prompt removal of blood or body substances contamination and surface disinfection of the area is a sound infection control practice and required by OSHA. Cleaning and disinfection schedules and methods may vary according to the area (dental operatory, laboratory, bathrooms, patient waiting rooms), surface, and amount and type of contamination. Housekeeping surfaces should be cleaned and decontaminated with an EPA-registered low-level disinfectant immediately or as soon as feasible when surfaces are overtly contaminated or after any spill of blood or other potentially infectious materials; and at the end of the work shift if the surface may have become contaminated since the last cleaning (Rutala 2002, OSHA 1991).

Cleaning and Disinfection Strategies for Spills of Blood

Strategies for decontaminating spills of blood and other body fluids differ by setting and by the volume of the spill (CDC 1987, Sehulster 2001). Most blood spills in dentistry are relatively small. 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. The person assigned to clean the spill should wear medical gloves and other personal protective equipment as needed. Visible organic material should be removed with absorbent material (e.g., disposable paper towels discarded in a leakproof, properly labeled container); the non-porous surface should be cleaned and then decontaminated with either a low-level disinfectant effective against HBV and HIV or an intermediate-level chemical disinfectant. If sodium hypochlorite is chosen, it is preferable to use an EPA-registered sodium hypochlorite product, but if such products are not available, a 1:100 dilution of sodium hypochlorite (approximately 1/4 cup household chlorine bleach to 1 gallon of water) is an inexpensive and effective disinfecting agent.

Carpeting and Cloth Furnishings

Carpeting is harder to clean than non-porous hard-surface flooring, and it cannot be reliably disinfected, especially after spills of blood and body substances (OSHA 1991). Several studies have documented the presence of diverse microbial populations, primarily bacteria and fungi, in carpeting (Gerson 1994, Suzuki 1984, Skoutelis 1993). Cloth furnishings pose similar contamination risks in areas of direct patient care and places where contaminated materials are

managed (e.g., dental operatory, laboratory, instrument processing area). For these reasons carpeted flooring and fabric-upholstered furnishings in these areas should be avoided.

Regulated Medical Waste

Several studies have compared the microbial load and the diversity of microorganisms in residential waste and waste from a variety of health-care settings. There is no epidemiological evidence to suggest that general waste from hospitals; other health-care facilities, including dental facilities; or clinical/research laboratories is any more infective than residential waste. Aesthetic and emotional considerations originating fairly early in the HIV epidemic (Keene 1989, Keene 1991, Rutala 1989, Rutala 1991), however, have resulted in the promulgation of federal, state, and local rules and regulations regarding medical waste management and disposal (Greene 1994, EPA 1997, Garner 1986, CDC 1996, CDC 1988).

Categories of Medical Waste

The most practical approach to managing medical waste is to identify waste that represents a sufficient risk of causing infection during handling and disposal and for which some special precautions may be indicated (Garner 1985). The risk of either injury or infection from certain sharp items (e.g., needles, scalpel blades) contaminated with blood also needs to be considered. Although any item that has had contact with blood, exudates, or secretions may be infective, it is not normally considered practical or necessary to treat all such waste as infective. Federal, state, and local guidelines and regulations specify the categories of medical waste subject to regulation and outline any requirements associated with treatment and disposal. Some examples of regulated waste found in a dental office are solid waste that is soaked or saturated with blood or saliva (e.g., gauze saturated with blood following surgery), extracted teeth, surgically removed hard and soft tissues, and sharp items (e.g., needles, scalpel blades, wires) (OSHA 1991).

Management of Regulated Medical Waste in Dental Health-Care Facilities

Medical waste requires careful disposal and containment before collection and consolidation for treatment. A single leak-resistant biohazard bag is usually adequate for containment of non-sharp 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 located at the point of use (e.g., sharps containers) are used as containment for scalpel blades, needles, syringes, and unused sterile sharps (OSHA 1991).

Health-care facilities should dispose of medical waste regularly to avoid accumulation. Any facility that generates regulated medical waste should have a regulated medical waste management plan to assure health and environmental safety as per federal, state, and local regulations.

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

All containers with blood or saliva remaining (e.g., suctioned fluids) may be inactivated in accordance with state-approved treatment technologies, or the contents can be carefully poured down a utility sink drain or toilet (CDC 1988). State regulations may dictate the maximum volume of blood or other body fluids that may be discharged into the sanitary sewer. There is no evidence that bloodborne diseases have been transmitted from contact with raw or treated

sewage. Many bloodborne pathogens, particularly viruses, are not stable in the environment for long periods of time (Slade 1989) and the discharge of small quantities of blood and other body fluids into the sanitary sewer is considered a safe method of disposing of these waste materials (CDC 1988).

Dental Unit Waterlines, Biofilm, and Water Quality

Studies have demonstrated that dental unit waterlines (narrow-bore plastic tubing that carries water to the high-speed handpiece, air/water syringe, and ultrasonic scaler) can become colonized with a variety of microorganisms, including bacteria, fungi, and protozoa (Walker 2000, Schulze-Robbecke 1995, Barbeau 1996, Atlas 1995, Kelstrup 1977, Challacombe 1995, Mayo 1990). 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. Once formed, the biofilm serves as a reservoir that may substantially amplify the number of free-floating (i.e., planktonic) microorganisms in water used for dental treatment.

Although oral flora (Scheid 1982, Bagga 1984, Walker 2000) and human pathogens, such as *Pseudomonas aeruginosa* (Martin 1987, Pankhurst 1990, Barbeau 1996, Walker 2000), *Legionella* species (Pankhurst 1990, Atlas 1995, Walker 2000), and non-tuberculous *Mycobacterium* species (Schulze-Robbecke 1995, Walker 2000), have been isolated from dental water systems, most organisms recovered from dental waterlines are common heterotrophic water bacteria (Barbeau 1996, Mills 1986, Williams 1993), which exhibit little pathogenic potential for immunocompetent persons.

Clinical Implications

Although there are very few reports of waterborne infections associated with dental water systems, a large body of scientific evidence verifies the potential for transmission of waterborne infections and disease in hospital settings and in the community. Infection or colonization due to *Pseudomonas* species or non-tuberculous mycobacteria can be transmitted to susceptible patients via direct contact with water (Jones 1985, Hollyoak 1995, Begg 1986, Laussucq 1988) or after exposure to residual waterborne contamination of inadequately reprocessed medical instruments (Struelens 1993, Kuritsky 1983, Bolan 1985). Non-tuberculous mycobacteria can also be transmitted to patients from tap water aerosols (Lessing 1993). Health-care-associated transmission of pathogenic agents such as *Legionella* species occurs primarily through the inhalation of infectious aerosols generated from potable water sources or the use of tap water in respiratory therapy equipment (Arnow 1982, Breiman 1990, Garbe 1985). Disease outbreaks in the community have also been reported from diverse environmental aerosol-producing sources, including whirlpool spas (Fallon 1990), swimming pools (Rose 1998), and grocery store mist machine (MMWR 1990). Although most of these outbreaks are associated with various species of *Legionella* bacteria and *Pseudomonas* species (Rose 1998), the aquatic fungus *Cladosporium* (Jacobs 1986) have also been implicated. Concentrations of bacterial endotoxin as high as 1000 endotoxin units/ml from gram-negative water bacteria have been detected in water from colonized dental units (Putnins 2001). There are no current standards for the acceptable level of endotoxin in drinking water, but the maximum level permissible in USP sterile water for irrigation is only 0.25 endotoxin units per ml (US Pharmacopeia 1997). 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 the onset of hypersensitivity pneumonitis in other occupational settings (Milton 1996, Rose 1998).

Researchers have not demonstrated a measurable risk of serious adverse health effects among DHCP or patients from exposure to dental water. Nevertheless, several studies found DHCP to have altered nasal flora (Clark 1974) or significantly higher titers of *Legionella* antibodies in comparisons with control populations; no cases of legionellosis were identified among exposed DHCP (Fotos 1985, Reinthaler 1988). A report from Great Britain suggests that contaminated dental water in post-treatment sites may have been the source for localized *Pseudomonas aeruginosa* infections of two immunocompromised patients (Martin 1987). Although transient carriage of *P. aeruginosa* was observed in 78 healthy patients treated with contaminated dental treatment water, no illness was reported in this group. In this same study, a retrospective review of dental records also failed to identify any infections among healthy patients (Martin 1987).

Dental Unit Water Quality

Standards for safe drinking water quality established by the EPA, the American Public Health Association (APHA) and the American Water Works Association (AWWA) set limits of no more than 500 colony-forming units (CFUs) of heterotrophic bacteria per ml of drinking water (EPA 1999, APHA 1999). Untreated or unfiltered dental unit waterlines are unlikely to meet drinking water standards (Walker 2000, Schulze-Robbecke 1995, Barbeau 1996, Atlas 1995, Kelstrup 1977, Challacombe 1995, Mayo 1990). Research has shown that microbial counts can reach as high as 200,000 CFU/ml within 5 days after installation of new dental unit waterlines (Barbeau 1996) and levels of microbial contamination as high as 10^6 colony forming units per milliliter of dental unit water (CFU/ml) have been documented (Mayo 1990, Santiago 1994). These counts can occur because dental unit waterline factors (e.g., system design, flowrates, materials) promote bacterial growth levels and the additional development of biofilm.

In 1998, the Association for the Advancement of Medical Instrumentation established that water in hemodialysis units should not have more than 200 CFU/ml (Arduino 1998). In 1995, the ADA applied this health-care standard to dental units, recommending dental manufacturers provide equipment with the ability to deliver treatment water with ≤ 200 CFU/ml of unfiltered output from waterlines (Shearer 1996). Exposing patients or DHCP to water of uncertain microbiological quality, despite the lack of documented adverse health effects, is inconsistent with generally accepted infection control principles. 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, less than the 500 CFU/ml standard for safe drinking water established by the EPA and the APHA/AWWA.

Strategies to Improve the Quality of Dental Unit Water

Although there is no current epidemiological evidence of a public health problem, the presence of potential human pathogens in dental unit waterlines generates concern. Meeting the 1993 recommendation that waterlines be flushed for several minutes at the beginning of the clinic day temporarily reduces the microbial load (Scheid 1982, Mayo 1990), but it does not seem to affect biofilm in the waterlines or to reliably improve the quality of water used during dental treatment (Williams 1993, Santiago 1994, Williams HN 1995). Because the recommended value of 500 CFU/ml or less cannot be consistently achieved using this method, other strategies must be

employed. Commercial devices and procedures designed to improve the quality of water used in dental treatment are available (Mills 2000); methods shown 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 less than 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. Currently, removal or inactivation of biofilms requires the use of chemical germicides, but other technological methods may become available in the future.

It is well established that patient material (e.g., oral microorganisms, blood, saliva) can enter the dental water system during patient treatment (Bagga 1984, Scheid 1990). Any dental device connected to the dental water system that enters the patient's mouth (e.g., handpieces, ultrasonic scalers, air/water syringe) should be run to discharge water and air for a minimum of 20-30 seconds after each patient (CDC 1993). This procedure is intended to physically flush out patient material that may have entered the turbine, air, or waterlines. Most recently manufactured dental units are engineered to passively prevent retraction of oral fluids, but older dental units are often equipped with anti-retraction valves that require periodic maintenance. Users should consult the owner's manual or contact the manufacturer to determine whether testing or maintenance of anti-retraction valves or other devices is required. Even in the presence of anti-retraction valves, flushing procedures for devices attached to air and waterlines should be followed as described.

Maintenance and Monitoring of Dental Unit Water

DHCP should be trained about water quality, biofilm formation, water treatment methods, and proper maintenance protocols for water delivery systems. Water treatment and monitoring products require strict adherence to maintenance protocols, and non-compliance with treatment regimens has been associated with persistence of microbial contamination in treated systems (Williams HN 1994). Clinical monitoring of water quality can ensure that procedures are properly 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. Because methods used to treat dental water systems target the entire biofilm, there is no rationale for routine testing for specific organisms such as *Legionella* or *Pseudomonas* except when investigating a suspected waterborne disease outbreak (2001).

Surgical Irrigation

Sterile saline or sterile water must be used as a coolant/irrigation in the performance of surgical procedures where there is a risk of microbial invasion of fascial spaces or the vascular system (see section entitled Surgical Procedures). Sterile water delivery devices should be used to deliver sterile water (CDC 1993, Garner Surgical Wound 1985). Conventional dental units cannot reliably deliver sterile water even when equipped with independent water reservoirs because the water-bearing pathway cannot be reliably sterilized. Sterile water systems for surgery and for dental implants bypass the dental unit and employ sterile disposable or autoclavable tubing. Oral surgery and implant handpieces as well as ultrasonic scalers that

deliver sterile water or other sterile solutions using single-use disposable or sterilizable tubing are commercially available (Mills, 2000).

Boil-Water Advisories

A boil-water advisory is a statement 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 in the event of: 1) failure of or significant 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*, *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., water main break] coupled with an indication of a health hazard; or 5) a natural disaster (e.g., flood, hurricane, earthquake) (Working Group 1997). In recent years, increased numbers of boil-water advisories have resulted from contamination of public drinking water systems with waterborne pathogens. The most notable event was the outbreak of cryptosporidiosis in Milwaukee, Wisconsin, when the municipal water system was contaminated with the protozoan parasite *Cryptosporidium parvum*. An estimated 403,000 persons became ill (MacKenzie 1994, Kaminski 1994).

During a boil-water advisory, water should not be delivered to patients through the dental operative 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., it is a separate water reservoir or other water treatment device that has been cleared for marketing by the 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 and cooled before use (CDC 1995, CDC 1996, Working Group 1997). For hand hygiene, antimicrobial products that do not require water, such as alcohol-based hand rubs, can be used until the boil-water notice is cancelled. If hands are visibly soiled, use bottled water and soap for handwashing or a detergent-containing towelette (Larson 1995, OSHA 1991).

When the advisory is cancelled, the local water utility should provide guidance for proper flushing of water lines to reduce residual microbial contamination. All incoming water lines from the public water system inside the dental office (e.g., faucets and water lines to dental equipment) should be flushed. There is no consensus as to the optimal duration for flushing procedures following the cancellation of the advisory; recommendations range from 1 to 5 minutes (2001, EPA Lead revisions 2000, EPA Lead final rule 2000, Working Group 1997). The length of time needed may vary with the type and length of the plumbing system leading to the office. After the incoming public water system lines are flushed, dental operative water lines should be disinfected according to the manufacturer's instructions (Working Group 1997).

Program Evaluation

The primary goal of an infection control program is to prevent errors and 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 people to make mistakes or fail to prevent them (IOM 1999). Effective program evaluation is a systematic way to improve and account for safe public health actions by

involving procedures that are useful, feasible, ethical, and accurate. Program evaluation is an essential organizational practice in public health; however, it is not practiced consistently across program areas, nor is it sufficiently well-integrated into the day-to-day management of most programs (CDC MMWR 1999). A successful infection control program depends on developing standard operating procedures, evaluating infection control 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 effectiveness of the infection control program could include periodic observational assessments, checklists to document procedures, and routine review of occupational exposures to bloodborne pathogens. Information gathered from the evaluation offers an opportunity to improve the effectiveness of the infection control program and to benefit office protocols. If the assessment determines there are deficiencies or problems in the implementation of certain infection control procedures, a further evaluation can be performed to identify and modify the contributing factors. The recommendations after each section in the guidelines may help in selecting infection control issues to evaluate. Several examples of elements (performance indicators) that could be evaluated in a dental practice are shown in Table 7.

Table 7. Examples of Elements to Evaluate

Element	Evaluation Example
Appropriate immunizations of DHCP	Conduct an annual review of individual 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 it could be prevented in the future.
Comprehensive postexposure management and medical follow-up program after occupational exposures to infectious agents	Ensure that 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 questions.
Adherence to hand hygiene before and after patient care	Observe and document circumstances of appropriate or inappropriate handwashing. Review findings in a safety meeting with all staff.
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 safety meeting with all staff.
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.
Proper handling and disposal of regulated medical waste	Observe the safe disposal of regulated medical waste and be proactive regarding hazardous situations.
Health-care associated infections	Assess the unscheduled return of patients after procedures and evaluate them for an infectious process. An increasing trend may require formal evaluation.
Compliance of water in routine dental procedures with current EPA drinking water standards (fewer than 500 CFU of heterotrophic water bacteria)	Monitoring of dental water quality may be performed by the dentist using commercial self-contained test kits, or it may be accomplished by commercial water testing laboratories. The manufacturer of the dental unit or water delivery system can determine the best method for maintaining and monitoring good water quality.

Special Considerations

Dental Handpieces and Other Devices Attached to Air and Waterlines

Several semicritical dental devices that touch mucous membranes are attached to the air and/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 there is no epidemiological evidence implicating these instruments in disease transmission (Gooch 1993), studies of high-speed handpieces using dye expulsion have confirmed the potential for retracting oral fluids into internal compartments of the device (Crawford 1988, Mills 1993, Lewis cross-contamination 1992, Lewis cross-infection 1992, Checchi 1998). This finding suggests that retained patient material may be expelled intraorally during subsequent uses. Studies using laboratory models also suggest the possibility for the retention of viral DNA inside both high-speed handpieces and prophlaxis angles; none, however, has assessed the presence of infectious virus (Lewis cross-contamination 1992, Lewis cross-infection 1992, Epstein 1995). The potential for contamination of the internal surfaces of other devices (e.g., low-speed handpiece and ultrasonic scalers), have not been studied, but restricted physical access limits their cleaning. Accordingly, any dental device that is connected to the dental water system and 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 (CDC 1993). This procedure is intended to help physically flush out patient material that may have entered the turbine and air and water lines (CDC 1993, Lewis cross-contamination 1992, Lewis cross-infection 1992).

Heat sterilization methods (e.g., steam under pressure, unsaturated chemical vapor) can effectively sterilize dental handpieces and other intraoral devices attached to air and/or waterlines (Pratt 1999, Lewis cross-contamination 1992, Lewis cross-infection 1992, Kolstad 1998). For reprocessing any dental device that can be removed from the dental unit air and/or waterlines, neither surface disinfection nor immersion in chemical germicides is an acceptable method. Ethylene oxide gas cannot adequately sterilize internal components of handpieces (Pratt 1999, Parker 1995, Food and Drug 1992). In clinical evaluations of high-speed handpieces, cleaning and lubrication were the most critical factors in determining performance and durability (Kuehne 1992, Anderson 1999, Leonard 1999). 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. These items do not enter the patient's oral cavity but are likely to become contaminated with oral fluids during treatment procedures (e.g., handles or dental unit attachments of saliva ejectors, high-speed air evacuators, and air/water syringes.). These components should be covered with impervious barriers that are changed after each use. If the item becomes visibly contaminated during use, clean and low- to intermediate-level disinfect before use on the next patient.

Saliva Ejectors

Research studies using clinical situations suggest that in about 1 in 5 cases previously suctioned dyed fluids might be retracted into the patient's mouth when a seal around the saliva ejector is created (e.g., by the patient closing her/his lips around the tip of the ejector) (Barbeau 1998, Mann 1996, Watson 1993). The CDC is not aware of any reports of adverse health effects

associated with the saliva ejector, but, in light of these findings, practitioners should not ask patients to close their lips around the tip of this device to evacuate oral fluids (Mann 1996).

Aseptic Technique for Parenteral Medications

Safe handling of parenteral medications and fluid infusion systems are required to prevent health-care associated infections in patients undergoing conscious sedation. Parenteral medications include a single-dose ampule, vial or pre-filled syringe usually without bacteriostatic/preservative agents and are intended for use on a single patient. Multiple dose vials, used for one or more patients, may have a preservative but both containers of medication must be handled with aseptic techniques to prevent contamination.

Single-dose vials might pose a risk for contamination if they are punctured several times. CDC recommends using single-dose vials for parenteral medications when possible. The leftover contents of a single-use vial should be disposed of appropriately and never be combined with other medications for use on another patient (ASPH Council 2000, Green 1995). Medication from a single-dose syringe must not be administered to multiple patients even if the needle on the syringe is changed (ASA 1999).

The overall risk for extrinsic contamination of multiple dose vials is likely minimal, although the consequences of contamination might result in life-threatening infection (Henry 2001). If it is necessary to use a multiple dose vial, cleanse the access diaphragm of a multiple dose vial with 70% alcohol before inserting a sterile device into the vial (Plott 1990, Arrington 1990). Discard a multiple dose vial if sterility is compromised (Plott 1990, Arrington 1990).

Do not carry medication vials, syringes, or supplies in pockets. If trays are used to deliver medications to individual patients, they must 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 (CDC 2001).

All fluid infusion and administration sets (IV tubings and connections) are single-patient use as sterility can not be guaranteed if 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 (ASA 1999).

Single-Use (Disposable) Devices

A single-use device, also called a disposable device, is intended to be used on one patient and then discarded appropriately. It is not intended to be reprocessed (cleaned, disinfected/sterilized) and used on another patient (FDA 2001). Common single-use items include saliva ejectors, syringe needles, prophylaxis angles, cups and brushes, high-volume evacuator tips, and air/water syringe tips.

Pre-procedural Mouth Rinses

Antimicrobial mouth rinses given before a dental procedure are intended to reduce the number of microorganisms the patient may release in the form of aerosols or spatter that subsequently may contaminate DHCP and equipment operatory surfaces. In addition, pre-procedural rinsing may decrease the number of microorganisms introduced in the patient's bloodstream during invasive dental procedures (Dajani 1990, Pallasch 1996).

The use of rotary dental and surgical instruments (e.g., handpieces, 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 either on the floor, nearby operatory surfaces, the DHCP, or the patient. The spray may also contain some aerosol. Aerosols take considerable energy to generate and consist of particles less than 10 μ in diameter that typically are not visible to the naked eye. Aerosols can remain airborne for extended periods and may be inhaled; they should not be confused with the large-particle spatter that makes up the bulk of the spray from handpieces and ultrasonic scalers. Appropriate use of dental dams (Cochran 1989), high-velocity air evacuation, and proper patient positioning should minimize the formation of droplets, spatter, and aerosols (CDC 1993).

To date, no scientific evidence indicates that pre-procedural mouth rinsing prevents clinical infections among DHCP or patients, but studies have shown that a pre-procedural rinse with a long-lasting antimicrobial (e.g., chlorhexidine gluconate, essential oils, povidone-iodine) can reduce the level of oral microorganisms generated during routine dental procedures with rotary instruments (e.g., dental handpieces, ultrasonic scalers) (Litsky 1970, Mohammed 1970, Wyler 1971, Muir 1978, Fine 1992, Fine 1993 Am J Dent, Fine 1993 J Am Dent Assoc, Logothetis 1995, Klyn 2001). Pre-procedural mouth rinses may be most beneficial before a procedure using a prophylaxis cup or ultrasonic scaler because rubber dams cannot be used to minimize aerosol and spatter generation; unless the provider has an assistant, high-volume evacuation is not commonly used (Miller 1998).

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 significant benefit has been shown for mouth rinsing in terms of reducing the number of oral microorganisms in dental-induced bacteremias (Brown 1998, Lockhart 1996). The current American Heart Association recommendations for preventing bacterial endocarditis during dental procedures (Dajani 1997), however, provide limited support for pre-procedural mouth rinsing with an antimicrobial as an adjunct for patients at risk of bacterial endocarditis.

Surgical Procedures

The oral cavity is colonized with numerous microorganisms. Surgical procedures present a greater 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, subcutaneous tissue) and increased potential for localized or systemic infection. Surgical procedures involve the incision, excision, or reflection of skin or oral mucosa that exposes the normally sterile areas

of the oral cavity. Examples of surgical procedures include biopsy, periodontal surgery, apical surgery, and extractions of teeth.

The wearing of sterile surgical gloves during surgical procedures is supported by a strong theoretical rationale (CDC 1988, CDC 1993, Mangram 1999, CDC Hand 2002). Sterile gloves minimize transmission of microorganisms from the hands of surgical personnel to patients and prevent contamination of the hands of surgical personnel with the patient's blood and body fluids (Mangram 1999). Although the effectiveness of wearing two pairs of gloves in preventing disease transmission has not been demonstrated, most studies among medical and dental personnel have shown a lower frequency of inner glove perforation and visible blood on the surgeon's hands when double gloves are worn (Gani 1990, Gerberding 1990, Short 1993, Schwimmer 1994, Tokars 1995, Patton 1995, Avery 1998, Burke 1996). In one study evaluating double gloves during oral surgical and dental hygiene procedures, the perforation of outer latex gloves was greater during longer (more than 45 minutes) than shorter procedures, with the highest rate, 10%, found during oral surgery procedures (Patton 1995). Based upon these studies, double gloving may provide additional protection from occupational blood contact. Double gloving does not appear to significantly reduce either manual dexterity or tactile sensitivity (Webb 1993, Watts 1994, Wilson 1996). Additional protection may be provided by specialty products (e.g., orthopedic surgical gloves, microsurgery gloves, glove liners) (FDA 1999).

Because skin bacteria can rapidly multiply under surgical gloves if hands are washed with a non-antimicrobial soap (Price 1938, Dewar 1973), an antiseptic (e.g., antimicrobial soap or alcohol-based hand rub) should be used before any surgical procedure (Lowbury 1960, Rotter 1999, Widmer 2000, CDC 2002).When performing surgical hand antisepsis using an antimicrobial soap, scrub hands and forearms for 2-6 minutes. When using an alcohol-based surgical hand-scrub product, prewash hands and forearms with a nonantimicrobial soap and dry hand and forearms completely. After application of the alcohol-based product, allow hands and forearms to dry thoroughly then immediately don sterile gloves and other personal protective equipment (e.g., surgical mask, protective eyewear, protective clothing) (Garner 1986, Larson 1990, Faoagali 1995).

Sterile water or other sterile irrigating solutions must be used when surgical procedures are performed in the oral cavity (CDC 1993, Garner surgical wound 1985) (see section entitled Dental Unit Water Quality). All reusable heat tolerant instruments and supplies used during the procedure must be heat sterilized and maintained in sterile packaging until the initiation of the procedure. Single-use devices should be sterile at the time of use.

Handling of Biopsy Specimens

To protect persons handling and transporting biopsy specimens, each specimen must be placed in a sturdy, leak-proof container with a secure lid to prevent leakage during transport (OSHA 1991). 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 (CDC 1993). The container must be labeled with the biohazard symbol during storage, transport, shipment, and disposal (OSHA 1991, OSHA 2001 CPL).

Handling of Extracted Teeth

Office Disposal

Extracted teeth, that are being discarded are subject to the containerization and labeling provisions of the Occupational Safety and Health Administration's Occupational Exposure to Bloodborne Pathogens: Final Rule in 1991 (OSHA 1991). OSHA considers extracted teeth to be potentially infectious material that should be disposed in medical waste containers. Extracted teeth may be returned to patients upon request, however, at which time they are no longer subject to the provisions of the standard (OSHA 2001 CPL). Extracted teeth containing dental amalgam should not be placed in a medical waste container that uses an incinerator for final disposal. 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 closed container. A liquid chemical germicide, (e.g., glutaraldehyde, 5.25% sodium hypochlorite) will disinfect the exterior of the tooth but not the interior pulp tissue(Tate 1991, Pantera 1988). Phenol and 1:10 dilution of sodium hypochlorite are not effective disinfectants (Tate 1991). Extracted teeth must be placed in a well-constructed container with a secure lid to prevent leaking during transport, and they need to be labeled with the biohazard symbol (OSHA 1991, OSHA 2001 CPL). Before being used in an educational setting, the teeth should be sterilized to allow for safe handling. Pantera and Shuster demonstrated elimination of microbial growth using an autoclave cycle for 40 minutes (Pantera 1990), but since preclinical educational exercises simulate clinical experiences, students enrolled in dental programs should still follow standard precautions. Autoclaving teeth for preclinical laboratory exercises does not alter their physical properties sufficiently to compromise the learning experience (Pantera 1990, Parsell 1998). It is not known, however, whether autoclave sterilization of extracted teeth affects dentinal structure to the point that the chemistry and microchemical relationship between dental materials and the dentin would be affected for research purposes on dental materials (Parsell 1998).

The use of teeth that do not contain amalgam is preferred in educational settings because they can be safely autoclaved (Pantera 1990, Tate 1991). Extracted teeth containing amalgam restorations must 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 (Tate 1991).

Dental Laboratory

Dental prostheses, appliances, and the items used in their fabrication (e.g., impressions, occlusal rims, bite registrations) should be handled in a manner that prevents exposure of personnel to infectious agents. In turn, DHCP and dental laboratory personnel must manage these items in a manner that prevents contamination of the material during handling and storage.

When a laboratory case is sent off-site, communication between the dental office and laboratory personnel regarding the handling and status of material decontamination is important. Specific

information regarding the disinfection technique (e.g., solution used, length of time) should be included with the laboratory case. This information is useful for laboratory personnel because it prevents duplication of the disinfection protocol and contamination of their environment (ADA 1996, CDC 1993, Kugel 2000).

Dental prostheses, prosthodontic materials (e.g., occlusal rims, temporary prostheses, bite registrations), orthodontic appliances, and impressions should be cleaned, disinfected with an appropriate intermediate-level disinfectant, and thoroughly rinsed before and after being manipulated in the laboratory (ADA 1996, CDC 1993, Rutala 1998, 2001, Favero 2001). Personal protective equipment (e.g., chemically-resistant gloves, face shield, surgical mask, protective eyewear, gowns) must be worn until disinfection is accomplished (OSHA 1991, CDC 1986, CDC 1987, CDC 1988, CDC 1993). DHCP are advised to consult with manufacturers regarding the stability of specific materials during disinfection.

Heat-tolerant items used in the mouth (e.g., metal impression tray, face bow fork) should be heat sterilized before being used on another patient (ADA 1996, CDC 1993). Laboratory items used on potentially contaminated appliances or prostheses (e.g., burs, polishing points, rag wheels) should be sterilized or high-level disinfected between cases or be disposable (Favero 2001, Rutala 1998, 2001). Items that do not normally contact the patient or the prosthetic device or appliance but frequently become contaminated and cannot withstand heat sterilization (e.g., articulators, case pans, lathes) should be cleaned and disinfected according to the manufacturer's instructions. In most instances these items can be cleaned and disinfected with a low-level disinfectant. Pressure pots and water baths are particularly susceptible to contamination with microorganisms and should be cleaned and disinfected at least daily (Plummer 1994). Environmental surfaces should be cleaned and disinfected in the same manner as in the dental treatment area.

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

Part II. Recommendations

Each recommendation is categorized on the basis of existing scientific data, theoretical rationale, and applicability. The CDC system for categorizing the Recommended Infection Control Practices for Dentistry, 2003 recommendations is as follows:

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 certain experimental, clinical, or epidemiologic studies and a strong theoretical rationale.

Category IC. Required for implementation, as mandated by federal or state regulation or standard.

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

No recommendation. Unresolved issue. Practices for which insufficient evidence or no consensus regarding efficacy exist.

I. Infection Control Elements of a Personnel Health Program

A. General Recommendations

1. Develop a written personnel health program for DHCP that includes: education and training, immunization programs, exposure prevention and postexposure management, medical conditions, work-related illness, and associated work restrictions, contact dermatitis, latex hypersensitivity, maintenance of records, data management, and confidentiality (IB) (Bolyard 1998, ACIP 1997, American Hospital Association 1997, Gershon 2000, Herwaldt 1997).
2. Establish referral arrangements with qualified health-care professionals to ensure prompt and appropriate provision of preventive services, occupationally-related medical conditions, and postexposure management with medical follow-up (IB, IC) (OSHA 1991, Bolyard 1998, CDC 2001, Herwaldt 1997).

B. Education and Training

1. Provide personnel, upon initial employment and periodically, with education and training regarding occupational exposure to potentially infectious agents and infection control appropriate and specific for their assigned duties (IB, IC) (Bolyard 1998, Garner 1996, Herwaldt 1997, Gershon 2000, OSHA 1991, OSHA CPL 2001, CDC 2001).
2. Provide educational information appropriate in content and vocabulary to the educational level, literacy, and language of personnel (IB) (Bolyard 1998).

C. Immunization Programs

1. Develop a written comprehensive policy on immunizing DHCP, including a list of all required and recommended immunizations (IB) (Bolyard 1998, ACIP 1997, AHA 1992).
2. Refer personnel to a prearranged qualified health-care professional or to their own health-care professional to receive all appropriate immunizations based on the latest recommendations and their medical history and risk for occupational exposure (IB) (Bolyard 1998, CDC immunization 1997).

D. Exposure Prevention and Postexposure Management

1. Develop a comprehensive postexposure management and medical follow-up program that includes: (IB, IC) (Bolyard 1998, CDC 2001, OSHA 1991, OSHA 2001 CPL).
   a. Policies and procedures for prompt reporting, evaluation, counseling, treatment, and medical follow-up of occupational exposures.
   b. Established referral mechanisms to a qualified health-care professional for medical evaluation and follow-up.

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

1. Develop and have readily available to all DHCP comprehensive written policies on work restriction and exclusion that include a statement of authority defining who may implement such restrictions and exclusions (IB) (Bolyard 1998, Herwaldt 1997).
2. Develop policies for work restriction and exclusion that encourage personnel to seek appropriate preventive and curative care, and report their illnesses or any medical conditions or medical treatments that may render them more susceptible to opportunistic infection or exposures and that do not penalize them with loss of wages, benefits, or job status (IB) (Bolyard 1998, Herwaldt 1997, Mangram 1999).
3. Develop policies and procedures for evaluating, diagnosing, and managing personnel or patients with suspected or known occupational contact dermatitis (IB) (CDC/NIOSH 1997).
4. Seek definitive diagnosis by a qualified health-care professional of any suspected latex allergy to carefully determine its specific etiology and appropriate treatment as well as work restrictions and accommodations (IB) (CDC/NIOSH 1997).

F. Maintenance of Records, Data Management, and Confidentiality

1. Establish, and keep updated, a confidential medical record (e.g., any immunization records and documentation of tests received as a result of an occupational exposure) for all DHCP. Dental facilities coordinating the infection control program with off-site providers may have such records maintained by these providers (IB, IC) (Bolyard 1998, OSHA 1991).
2. Ensure that all applicable current federal, state, and local laws on medical record-keeping and confidentiality are complied with (IC) (OSHA 1991, OSHA reporting 2001).

II. Preventing Transmission of Bloodborne Pathogens

A. Hepatitis B Virus Vaccination

1. Ensure that all DHCP who perform tasks involving contact with blood or blood-contaminated saliva receive the appropriate hepatitis B vaccination series (IA, IC) (OSHA 1991, CDC immunization 1997, CDC 1993, CDC 1991 comprehensive strategy).
2. Test DHCP for anti-HBs 1 to 2 months after completion of the 3-dose vaccination series (IA) (CDC Immunization 1997).
3. Revaccinate non-responders using the 3-dose series and retest for response in 1 to 2 months (IB) (CDC Immunization 1997).
4. Evaluate non-responders after second 3-dose vaccination series to determine if they are HBsAg-positive (IB) (CDC Immunization 1997).

B. Preventing and Managing Exposures to Blood

1. General Recommendations

a. Consider sharp items (e.g., needles, scalpel blades, wires) that are contaminated with patient blood and saliva as potentially infective and establish engineering controls and work practices to prevent injuries (IB, IC) (CDC HIV 1987, CDC 1988, OSHA 1991).
b. Implement a written, comprehensive program designed to minimize and manage employee exposure incidents to blood and body fluids (IB, IC) (OSHA 2001 CPL, OSHA 1991, CDC 2001, NIOSH 1999).

2. Engineering and Work Practice Controls

a. Identify, evaluate and select devices with engineered safety features as they become available on the market (e.g., safer anesthetic syringes, blunt suture needle, retractable scalpel, needleless IV system) (IA, IC) (OSHA 2001 needlestick, CDC 1997 phlebotomy, CDC 1997 blunt suture needles, NIOSH 1999).
b. Place used disposable syringes and needles, scalpel blades, and other sharp items in appropriate puncture-resistant containers located as close as practical to the area in which the items are used (IA, IC) (OSHA 1991, CDC HIV 1987, CDC 1988, CDC 1989, CDC dentistry 1993, CDC NIOSH containers 1998).
c. Do not recap used needles 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) (OSHA 1991, CDC HIV 1987, CDC 1988, CDC 1989, CDC dentistry 1993, NIOSH 1999).
d. If necessary to recap needles (e.g., prior to removing from a non disposable aspirating syringe), use either a one-handed "scoop" technique or a mechanical device designed for holding the needle sheath (IA, IC) (CDC HIV 1987, CDC 1988, CDC 1989, CDC 1993, OSHA 1991).

3. Postexposure Prophylaxis

a. Follow current CDC recommendations for postexposure management and prophylaxis after percutaneous, mucous membrane, or non-intact skin exposure to blood or blood-contaminated saliva (IA, IC) (OSHA 1991, CDC 2001, OSHA 2001 CPL).

III. Preventing the Transmission of *Mycobacterium tuberculosis* (TB)

A. General Recommendation

1. Educate all DHCP regarding the recognition of signs and symptoms and transmission risk of tuberculosis (IB) (CDC 1994, Cleveland 1995).
2. Assess the patient for a history of TB and symptoms suggestive of TB and document on the medical history form (IB) (CDC 1994, Cleveland 1995).
3. Follow current CDC recommendations for (a) developing, maintaining, and implementing a written TB infection control plan; (b) management of a patient with suspected or active TB; (c) a community risk assessment guiding employee tuberculin skin testing and follow-up; and (d) tuberculosis exposure management of personnel (IB) (CDC 1993, Cleveland 1995).
4. A baseline TST (preferably using a two-step test) is recommended for all HCWs who may have contact with persons with suspected or confirmed infectious TB, regardless of the risk classification of the setting (IB) (CDC 1994).

B. For patients known or suspected to have active TB:

1. After check-in screening, staff should wear respiratory protection and evaluate the patient in a room with a closed door. When not being evaluated, the patient should wear a surgical mask or be instructed to cover their mouth and nose when coughing or sneezing (IB) (CDC 1994, Cleveland 1995).
2. Defer elective dental treatment until the patient is non infectious (IB) (CDC 1994, Cleveland 1995).
3. Use respiratory protection and engineering controls in a previously identified facility if urgent dental treatment is required (IB) (CDC 1994, Cleveland 1995).

IV. Personal Protective Equipment

A. Masks, Protective Eyewear, Face Shields

1. Wear a surgical mask and eye protection with solid side shields 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) (OSHA 1991, Garner 1996, Mangram 1999, CDC HIV 1987, CDC 1988, CDC 1986, CDC 1993).
2. Change masks between patients, or during patient treatment when the mask becomes wet (IB, IC) (CDC 1993, OSHA 1991).
3. Clean and disinfect reusable facial protective equipment (e.g., protective eyewear, face shield) between patients (IC) (OSHA 1991, CDC 1993).

B. Protective Apparel

1. Wear long-sleeved protective clothing such as reusable or disposable gowns, laboratory coats, or uniforms when skin or personal clothing is likely to be soiled with blood, saliva, or other potentially infectious materials (IB, IC) (OSHA 1991, Garner 1996, Mangram 1999, CDC 1987, CDC 1988).
2. Protective apparel should be changed if visibly soiled (Mangram 1999) and should be changed immediately or as soon as feasible if penetrated by blood or other potentially infectious fluids (IB, IC) (OSHA 1991).
3. Remove barrier protection, including gloves, masks, eyewear, and gowns, before departing areas of the dental office used for laboratory or patient care activities (IC) (OSHA 1991).

C. Gloves

1. Wear medical gloves when there is a potential for contacting blood, saliva, or mucous membranes (IB, IC) (OSHA 1991,CDC 1985, 86, 87,88).
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) (CDC 1986, 87, 88, 2002, OSHA 1991).
3. Remove gloves that are torn, cut, or punctured as soon as safety permits, and wash hands before regloving (IB, IC) (OSHA 1991, Wright 1991, Dodds 1988).
4. Do not wash surgical or patient examination gloves before use or wash, disinfect, or sterilize gloves for reuse (IB, IC) (Adams 1992, Martin 1988, DeGroot-Kosolcharoen 1989, Doebbeling 1988, OSHA 1991).
5. Ensure that the task-appropriate glove in the appropriate size is readily accessible (OSHA 1991).
6. Wear sterile surgical gloves when performing surgical procedures (IB) (CDC 1988, CDC 1993, Mangram 1999, CDC Hand 2002).
7. Use puncture- and chemical-resistant/heavy-duty utility gloves for housekeeping procedures involving potential blood or saliva contact, cleaning instruments, and performing decontamination (IB) (CDC 1988).

V. Contact Dermatitis and Latex Hypersensitivity

A. Educate DHCP about the signs, symptoms, and diagnoses of skin reactions associated with frequent hand hygiene and glove use (IB) (Bolyard 1998, ADA 1999, CDC/NIOSH 1997, Terezhalmy Personnel 1996).

VI. Hand Hygiene

A. General Considerations

1. When hands are visibly dirty or contaminated with proteinaceous material or are visibly soiled with blood or other body fluids, perform hand hygiene with either a non-antimicrobial soap and water or an antimicrobial soap and water. If hands are not visibly soiled, a non-antimicrobial soap, an antimicrobial soap, or an alcohol-based hand rub may be used (IA) (CDC Hand 2002).
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) (OSHA 1991, CDC Universal Precautions 1988, CDC HIV 1987, Garner 1986, Larson 1995, Steere 1995, Larson 2000, Pittet 2000, CDC Hand 2002, Garner 1996, Doebbeling 1988).

3. For surgical procedures, perform surgical hand antisepsis using either:
a) an antimicrobial soap and water or
b) soap and water followed by alcohol-based hand rub with persistent activity before donning sterile gloves (IB) (Price 1938, Dewar 1973, Lowbury 1960, Rotter 1999, Widmer 2000, Larson 1995, Garner 1986, Larson 1990, Faoagali 1995).

4. Store liquid hand care products in closed containers and in either disposable containers or containers that are washed and dried before refilling. Do not add soap or lotion ("topping off") to a partially empty dispenser (IA) (Larson 1995, Steere 1975, Garner 1986, Archibald 1997, Grohskopf 2001).

B. Special Considerations for Hand Hygiene and Glove Usage

1. Use lotions to prevent skin dryness associated with handwashing at the end of the work day (IA) (Berndt 2000, McCormick 2000).
2. Compatibility between lotion and antiseptic products and the effect of petroleum or other oil emollients on the integrity of gloves should be considered during product selection and glove usage (IB) (MMWR 1993, Garner Supercedes 1986, OSHA 2001 CPL, Larson 1993, Larson 1995).
3. Keep nails short enough to allow thorough cleaning and to prevent glove tears (II) (McGinley 1988, Larson 1995).
4. Do not wear artificial nails (IB) (Pottinger 1989, McNeil 2001, Rubin 1988, Hedderwick 2000, Passaro 1997, Foca 2000, Parry 2001, Moolenaar 2000). (This recommendation is IA when having direct contact with patients at high risk (e.g., those in intensive care units, or operating rooms) (CDC 2002).
5. Do not wear hand or arm jewelry during surgical procedures (II) (Mangram 1999).
6. Do not wear hand or nail jewelry during non-surgical procedures if they make donning gloves more difficult or compromise the appropriate fit and integrity of the glove. (II) (Larson 1989, Field 1996).

VII. Sterilization and Disinfection of Patient Care Items

A. General Recommendations

1. Clean and heat sterilize heat-tolerant critical and semicritical dental instruments before use (IA) (ADA 1996, CDC 1993, FDA 1992).
2. Clean and, at a minimum, high-level disinfect heat-sensitive semicritical items (IA) (ADA 1996, CDC 1993).

3. After use, clean and disinfect noncritical patient care items with a low- to intermediate-level disinfectant (i.e., use an intermediate level disinfectant if visibly contaminated with blood) (II) (CDC 1993, Rutala 2002).
4. Each worker should be informed of the possible health effects of their exposure to chemical agents used for disinfection and sterilization. The information should comply with OSHA requirements and identify the areas and tasks in which there is potential exposure (IC) (OSHA 1994).

B. Instrument Reprocessing Area

1. Designate a central reprocessing area. Divide the instrument reprocessing area, physically (or spatially at a minimum), into distinct areas for: a) receiving, cleaning, and decontamination; b) preparation and packaging; c) sterilization; and d) storage. Do not store instruments in an area where contaminated instruments are held or cleaned (II) (AAMI 1998, Miller 1998, AAMI 2002).
2. Train DHCP to apply work practices that prevent contamination of clean areas (II).

C. Receiving, Cleaning, and Decontamination Work Area

1. Remove all visible blood and organic contamination from dental instruments and devices before sterilization or disinfection procedures (IA) (Favero 2001, Parker 1995, Alfa 1998, Rutala 1998).
2. Use automated cleaning equipment (e.g., ultrasonic cleaner, washer-disinfector) to remove debris to improve cleaning effectiveness and decrease worker exposure to blood (IB) (CDC 1993, Miller 2000).
3. If manual cleaning is necessary, use work practice controls (e.g., long-handled brush) that minimize contact with sharp instruments (IC) (OSHA 2001 CPL).
4. Wear puncture- and chemical-resistant/heavy-duty utility gloves for housekeeping procedures involving potential blood or saliva contact and for instrument cleaning and decontamination procedures (IB) (CDC 1988).
5. Wear face mask, eye protection, and gowns when splashing or spraying is anticipated during cleaning (IC) (OSHA 1991).

D. Preparation and Packaging

1. Critical and semicritical items that will not be used immediately should be wrapped or placed in rigid containers before sterilization (IA) (CDC 1993, Ninemeier 1998, AAMI 1993, AAMI 1996, AAMI 1999, Rutala 2000).
2. Use a rigid container or wrapping compatible with the type of sterilization process used (IA) (AAMI 1993, AAMI 1996, AAMI 1999, Rutala 2000).

E. Sterilization Procedures

1. General Recommendation

a. Use only FDA-cleared medical devices for sterilization and follow the manufacturer's instructions for proper use (IB) (AAMI 1998).

2. Flash Sterilization

a. Do not use flash sterilization as a routine sterilization procedure for patient care items; only when unavoidable (e.g., an item is inadvertently dropped) (IB) (Mangram 1999, Hood 1997, Rutala 1999).
b. Do not flash sterilize implantable devices unless sterilization is verified by biological monitoring results (IA) (AORN 2002).
c. Document the mechanical, chemical, and biological monitors for every flash sterilization cycle (IB) (AAMI 1996, Vesley 1992, Rutala 1993).

3. Processing Heat-Sensitive Instruments

a. Use heat tolerant rather than heat-sensitive instruments whenever possible. Single-use disposable instruments are acceptable alternatives when available (IB) (Rutala 2002 draft).
b. Use a low-temperature sterilization method (e.g., ethylene oxide, hydrogen gas plasma) or a liquid chemical germicide cleared by the FDA as a "sterilant" (i.e., sterilant/high-level disinfectant) to reprocess a heat-sensitive instrument. Follow the manufacturer's instructions for the use of chemical sterilants (IB) (Rutala 2002).

4. Barrier Protected Semicritical Instruments

a. Use FDA-cleared barriers (IB)
b. Barrier protected semicritical items should be cleaned and high-level disinfected or sterilized between patients. Consult with the manufacturer for proper disinfection and sterilization methods (IB) (Rutala 2002).

F. Sterilization Monitoring

1. Use mechanical, chemical, and biological monitors according to the manufacturer's instructions to ensure the effectiveness of the sterilization process (IA) (Greene 1992, Favero 1998, AAMI 1998).
2. Each load should be monitored with mechanical (e.g., time, temperature, pressure) and chemical indicators (II) (AAMI 1998, Rutala 2002).
3. Place a chemical indicator on the inside of each package. If it is not visible from the outside, place an additional chemical indicator on the outside of the package (II) (AAMI 1993, Rutala 2002).
4. Do not use instrument packs if mechanical or chemical indicators suggest inadequate processing (IB) (AORN 2002, AAMI 1998).
5. Monitor sterilizers with biological and control indicators at least weekly (IB) (Garner 1986, CDC 1993, Greene 1992, Favero 1998, Rutala 2002, AORN 2002).
6. Use a biologic and control indicator for every sterilizer load that contains an implantable device. Results should be verified before use of the implantable device whenever possible (IB) (AAMI 1998).
7. In the case of a positive spore test, repeat the test immediately and review sterilization procedures (IB) (AORN 1987, Garner 1986).
8. Recall (as far as possible) and reprocess all items from a suspect load(s) if a second spore test remains positive for bacterial growth (IB) (AORN 1987, Garner 1986).

9. If spore tests remain positive, use of the sterilizer should be discontinued until it is serviced and results of retesting are satisfactory (IB) (Garner 1986, Rutala 2002).
10. Maintain sterilization records (mechanical, chemical, biological) in compliance with state and local regulations (IB) (JCAHO 2001).

G. Storage Area for Sterile and Clean Patient Care Items

1. Implement practices based on date- or event-related shelf-life for the storage of wrapped, sterilized instruments and devices (IB) (Rutala 2002, Mayworm 1984).
2. Examine wrapped packages of sterilized instruments before opening them to ensure the barrier wrap has not been compromised during storage (IB) (Mayworm 1984).
3. Repack and re-sterilize any instrument package that is compromised (II).
4. Store sterile supplies in covered or closed cabinets (IB) (Cardo 1999 in Mayhall text).

VIII. Environmental Infection Control

A. General

1. Follow the manufacturer's instructions for proper use of cleaning and EPA-registered hospital disinfecting products (IB) (Russell 2000, Rutala 1984, Sehulster 2001 Rutala 2002)
2. Wear gloves and other personal protective equipment (as appropriate) when cleaning and disinfecting environmental surfaces (IC) (OSHA 1991, OSHA 1994).

B. Clinical Contact Surfaces

1. Clean and disinfect clinical contact surfaces that can be thoroughly cleaned using a low-level (label claims effectiveness against HIV and HBV) to intermediate-level hospital disinfectant after each patient (i.e., use an intermediate level disinfectant if visibly contaminated with blood) (IB) (CDC 1993, Rutala 2002).
2. Use barriers to protect clinical contact surfaces that are difficult to clean (e.g., switches on dental chairs) and change surface barriers between patients (II) (CDC 1986, CDC 1993, Crawford 1987, Miller 2001).

C. Housekeeping Surfaces

1. Clean and low-level disinfect housekeeping surfaces using an EPA-registered hospital disinfectant on a regular basis (e.g., as appropriate based upon the location in the facility) and when visibly soiled (IB, IC) (Rutala 2002, OSHA 1991).

D. Spills of Blood and Body Substances

1. Clean and decontaminate spills of blood or other potentially infectious materials with a hospital low-level (label claims effectiveness against HBV and HIV) to intermediate-level disinfectant depending on size of spill and surface porosity (IC) (CDC 1987, OSHA 1991, OSHA 1997).

E. Carpet and Cloth Furnishings

1. Do not use carpeting and cloth-upholstered furnishings in dental operatories, laboratories, and instrument processing areas (IB) (Garner 1986, Gerson 1994, Suzuki 1984, Skoutelis 1993).

F. Regulated Medical Waste

1. General

a. Develop a medical waste management program as per federal, state, and local regulations (IC) (OSHA 1991, EPA 1997).
b. Ensure that DHCP who handle and dispose of potentially infective wastes are trained in appropriate handling and disposal methods and that they are informed of the possible health and safety hazards (IC) (OSHA 1991).

2. Management of Regulated Medical Waste in Dental Health-Care Facilities

a. Use a leak-resistant biohazard bag to contain "non-sharp" regulated medical waste (IC) (OSHA 1991).
b. Place sharp items (e.g., needles, scalpel blades, orthodontic bands, broken metal instruments, burs) in puncture-resistant biohazard containers. Containers should be closed immediately prior to removal or replacement to prevent spillage or protrusion of contents during handling, storage, transport, or shipping (IC) (OSHA 1991, CDC HIV 1987, CDC 1989, CDC 1993, CDC NIOSH containers 1998).

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

a. Blood, suctioned fluids or other liquid waste may be poured carefully into a drain connected to a sanitary sewer system, provided that local sewage discharge requirements are met and that the state has declared this to be an acceptable method of disposal (II) (Garner 1986, CDC 1988).

IX. Dental Unit Waterlines, Biofilm, and Water Quality

A. General Recommendations

1. Use water that meets standards set by the EPA for drinking water (fewer than 500 CFU/ml of heterotrophic water bacteria) for routine dental treatment output water (IB, IC) (EPA 1999, APHA 1999).
2. Consult with the dental unit manufacturer for appropriate methods and equipment to maintain the recommended quality of dental water (II) (Shearer 1996).
3. Follow recommendations for monitoring water quality provided by the manufacturer of the unit or waterline treatment product (II).
4. After each patient, discharge water and air for a minimum of 20-30 seconds from any dental device connected to the dental water system that enters the patient's mouth (e.g., handpieces, ultrasonic scalers, air/water syringe) (II) (CDC 1993).
5. Consult with the dental unit manufacturer on the need for periodic maintenance of anti-retraction mechanisms (IB) (CDC 1993, Bagga 1984).

B. Surgical Irrigation

1. Use sterile saline or sterile water as a coolant/irrigator when performing surgical procedures; use devices specifically designed for the delivery of sterile irrigating fluids (e.g., bulb syringe, single-use disposable products, sterilizable tubing (IB) (Garner Surgical Wound 1985, CDC 1993).

C. Boil-Water Advisories

1. 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 (IC-related to municipal water utility) (CDC 1995, CDC 1996, Working Group 1997).

b. Do not use water from the public water system for dental treatment, patient rinsing, or handwashing (IC-related to municipal water utility) (CDC 1995, CDC 1996, Working Group 1997).

c. Use antimicrobial-containing products for handwashing, that do not require water for use, such as alcohol-based hand rubs. If hands are visibly soiled, used bottled water and soap for handwashing or a detergent-containing towelette (IB, IC) (Larson 1995, OSHA 1991).

2. When the boil-water advisory is cancelled:

a. Follow guidance given by the local water utility on proper flushing of waterlines. If no guidance is provided, flush dental waterlines and faucets for 1-5 minutes before using for patient care (IC) (2001, EPA lead revisions 2000, EPA lead final 2000, Working Group 1997).

b. Disinfect dental waterlines as recommended by the dental unit manufacturer (II).

X. Program Evaluation

A. Dental facilities should establish an infection control program evaluation, based on evaluation of performance indicators at an established frequency (II) (CDC MMWR 1999, IOM 1999).

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

A. 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) (Pratt 1999, Lewis contamination 1992, Lewis cross-infection 1992, Kolstad 1998, CDC 1993, ADA 1996, FDA 1992).

B. Follow the manufacturer's instructions for the cleaning, lubrication, and sterilization of handpieces and other intraoral instruments that can be removed from the air and waterlines of dental units (IB) (Kuehne 1992, Andersen 1999, Leonard 1999).

C. 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) (CDC 1993, FDA 1992, Pratt 1999, Parker 1995).

D. Do not advise patients to close their lips around the tip of the saliva ejector to evacuate oral fluids (II) (Barbeau 1998, Mann 1996, Watson 1993).

XII. Aseptic Technique for Parenteral Medications

A. Medication from a single-dose syringe must not be administered to multiple patients even if the needle on the syringe is changed (IA) (ASA 1999).
B. Use single-dose vials for parenteral additives or medications when possible (II) (ASPH Council 2000, Green 1995).
C. Do not combine the leftover content of single-use vials for later use (IA) (ASPH Council 2000, Green 1995).
D. If multiple dose vials are used,
    1. Cleanse the access diaphragm of multiple dose vials with 70% alcohol before inserting a device into the vial (IA) (Plott 1990, Arrington 1990).
    2. Use a sterile device to access a multiple dose vial and avoid touch contamination of the device before penetrating the access diaphragm (IA) (Plott 1990, Arrington 1990).
    3. Refrigerate multiple dose vials after they are opened if recommended by the manufacturer (II).
    4. Discard multiple dose vial if sterility is compromised (IA) (Plott 1990, Arrington 1990).
E. All fluid infusion and administration sets (IV tubings and connections) are single-patient use (IB) (ASA 1999).

XIII. Single-Use (Disposable) Devices

A. Use single-use devices for one patient only and dispose of them appropriately (IC) (FDA 2001).

XIV. Surgical Procedures

A. When performing surgical procedures:
    1. Use sterile surgical gloves (IB) (CDC 1988, CDC 1993, Mangram 1999, CDC Hand 2002).
    2. Perform surgical hand antisepsis using an antimicrobial product (e.g., antimicrobial soap or soap and water followed by alcohol-based hand rub with persistent activity) before donning sterile surgical gloves (IB) (Price 1938, Dewar 1973, Lowbury 1960, Rotter 1999, Widmer 2000, Larson 1995, Garner 1986, Larson 1990, Faoagali 1995).
    3. Use sterile water or other sterile irrigating solutions (IB) (Garner Surgical Wound 1985, CDC 1993).

XV. Handling of Biopsy Specimens

A. Place biopsy specimens in a sturdy, leak-proof container during transport labeled with the biohazard symbol (IC) (OSHA 1991, CDC 1993, OSHA CPL 2001).
B. Clean and disinfect the outside of a biopsy specimen container if it is visibly contaminated, or place it in an impervious bag labeled with the biohazard symbol (IC) (OSHA 1991, CDC 1993).

XVI. Handling of Extracted Teeth

A. Extracted teeth should be disposed of as regulated medical waste unless returned to the patient (IC) (OSHA 1991, OSHA CPL 2001).
B. Extracted teeth containing amalgam should not be disposed of in regulated medical waste intended for incineration (II).
C. For transport to educational institutions, clean and place extracted teeth in a leakproof, closable container labeled with a biohazard symbol and containing an appropriate disinfectant (IB, IC) (Tate 1991, OSHA 1991, OSHA CPL 2001).
D. Heat sterilize teeth that do not contain amalgam before they are used for educational purposes (IB) (Pantera 1990, Parsell 1998, Tate 1991).

XVII. Dental Laboratory

A. Clean, disinfect, and rinse all dental prostheses and intermediate prosthodontic materials (e.g., occlusal rims) before and after they are manipulated in the laboratory. A chemical germicide having at least an intermediate level of activity is appropriate for such disinfection (IB) (Favero 2001, Rutala 1998, ADA 1996, CDC 1993).
B. Consult with manufacturers regarding the stability of specific materials (e.g., impression materials) relative to disinfection procedures (II).
C. Use personal protective equipment until items have been decontaminated (IA, IC) (OSHA 1991, CDC 1986, CDC HIV 1987, CDC 1988, CDC 1993).
D. When laboratory cases are sent off-site and upon their return, include specific information regarding the disinfection technique used (e.g., solution used, duration) (II) (ADA 1996, CDC 1993, Kugel 2000).
E. Clean and heat sterilize heat-tolerant items used in the mouth (e.g., metal impression trays, face-bow forks) (IB)(ADA 1996, CDC 1993).
F. Laboratory equipment (e.g., burs, polishing points, rag wheels) that touch contaminated appliances should be disposable or heat sterilized before reuse (IB) (Favero 2001, Rutala 1998).
G. Follow the manufacturer's instructions for cleaning and disinfecting items that do not normally contact the patient (e.g., articulators, case pans, lathes) (II).

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Appendix 1

Sample Resources for Infection Control Guidelines and Documents

Advisory Committee on Immunization Practices	http://www.cdc.gov/nip/ACIP/default.htm
American Dental Association	http://www.ada.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/infection_control/index.htm
CDC Morbidity and Mortality Weekly Report	http://www.cdc.gov/mmwr/
CDC Recommends…Prevention Guidelines System	http://www.phppo.cdc.gov/cdcRecommends/AdvSearchV.asp
Food and Drug Administration	http://www.fda.gov
Immunization Action Coalition	http://www.immunize.org/acip/
Infectious Diseases Society of America	http://www.idsociety.org/PG/toc.htm
National Institute for Occupational Safety and Health	http://www.cdc.gov/niosh/homepage.html
Occupational Safety and Health Administration, Dentistry	http://www.osha.gov/html/a-z-index.html#B
Organization for Safety and Asepsis Procedures	http://www.osap.org/
Society for Healthcare Epidemiology of America, Inc.	http://www.shea-online.org/PositionPapers.html

Appendix 2. Immunobiologics and schedules for health-care personnel (modified from ACIP recommendations [CDC Immunization 1997]): Immunizing agents strongly recommended for health-care personnel[#]

Generic name	Primary booster dose schedule	Indications	Major precautions and contraindications	Special considerations
Hepatitis B recombinant vaccine	Two doses IM in the deltoid muscle, 4 wk apart; 3rd doses 5 mo after 2nd; booster doses not necessary	Health-care personnel at risk of exposure to blood and body fluids	History of anaphylactic reaction to common bakers yeast. No apparent adverse effects to developing fetus, not contra-indicated in pregnancy	No therapeutic or adverse effects on 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 vaccines; health-care personnel who have ongoing contact with patients or blood should be tested 1-2 mo after completing the vaccination series to determine serologic response
Influenza vaccine (inactivated whole or split virus)	Annual single-dose vaccination IM with current (either whole or split-virus) vaccine	Health-care personnel with contact with high-risk patients or working in chronic care facilities; personnel with high-risk medical conditions and/or ≥65 yr	History of anaphylactic hypersensitivity after egg ingestion or to egg protein	Recommended during 2nd and 3rd trimesters of pregnancy. No evidence of maternal or fetal risk when vaccine was given to pregnant women with underlying conditions that rendered them at high risk for serious influenza complications
Measles live-virus vaccine	One dose SC; 2nd dose at least 1 mo later	Health-care personnel born in or after 1957 without documentation of (a) receipt of two doses of live vaccine on or after their 1st birthday, (b) physician-diagnosed measles, or (c) laboratory evidence of immunity; vaccine should be considered for all personnel, including those born before 1957, who have no proof of immunity	Pregnancy; immuno-compromised* state (including HIV-infected persons with severe immuno-suppression); history of anaphylactic reactions after gelatin ingestion or receipt of neomycin; or recent receipt of immune globulin	MMR is the vaccine of choice if recipients are also likely to be susceptible to rubella and/or mumps; persons vaccinated between 1963 and 1967 with (a) a killed measles vaccine alone, (b) killed vaccine followed by live vaccine, or (c) a vaccine of unknown type should be revaccinated with two doses of live measles vaccine
Mumps live-virus vaccine	One dose SC; no booster	Health-care personnel believed to be susceptible can be vaccinated; adults born before 1957 can be considered immune	Pregnancy; immuno-compromised* state; history of anaphylactic reaction after gelatin ingestion or receipt of neomycin	MMR is the vaccine of choice if recipients are also likely to be susceptible to measles and rubella

Rubella live-virus vaccine	One dose SC; no booster	Health-care personnel, both male and female, who lack documentation of receipt of live vaccine on or after their 1st birthday, or of laboratory evidence of immunity; adults born before 1957 can be considered immune, except women of childbearing age	Pregnancy; immuno-compromised* state; history of anaphylactic reaction after receipt of neomycin	Women pregnant when vaccinated or who become pregnant within 3 mo of vaccination should be counseled on the theoretic risks to the fetus, the risk of rubella vaccine-associated malformations in these women is negligible; MMR is the vaccine of choice if recipients are also likely to be susceptible to measles or mumps
Varicella-zoster live-virus vaccine	Two 0.5-ml doses SC 4-8 wk apart if ≥13 yr	Health care personnel without reliable history of varicella or laboratory evidence of varicella immunity	Pregnancy; immuno-compromised* state; history of anaphylactic reaction after receipt of neomycin or gelatin; salicylate use should be avoided for 6 wk after vaccination	Because 71%-93% of persons without a history of varicella are immune, serologic testing before vaccination may be cost-effective

(IM, *intramuscularly;* SC, *subcutaneously*; HBV, *hepatitis B virus*; MMR, *measles, mumps and rubella)*

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

#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.

Appendix 3. Modified from CDC Personnel Health Guideline, 1998. Summary of suggested work restrictions for health care personnel exposed to or infected with infectious diseases of importance in health care settings, in the absence of state and local regulations (modified from ACIP recommendations) (Bolyard 1998)

Disease/problem	Work restriction	Duration
Conjunctivitis	Restrict from patient contact and with the patient's environment	Until discharge ceases
Cytomegalovirus infection	No restriction	
Diarrheal disease		
Acute state (diarrhea with other symptoms)	Restrict from patient contact, contact with the patient's environment, or food handling	Until symptoms resolve
Convalescent state, *Salmonella* spp.	Restrict from care of high-risk patients	Until symptoms resolve; consult with local and state health authorities regarding need for negative stool cultures
Diphtheria	Exclude from duty	Until antimicrobial therapy completed and 2 culture obtained 24 hours apart are negative
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 antigemia who do not perform exposure-prone procedures	No restriction*; refer to state regulations. Standard precautions should always be utilized	
Personnel with acute or chronic hepatitis B e antigenemia 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 the worker can perform, taking into account specific procedures as well as skill and technique of worker; standard precautions should always be observed. Refer to state and local regulations or recommendations.**	Until hepatitis B e antigen is negative
Hepatitis C	No restriction*; Standard precautions should always be utilized#	
Herpes simplex		
Genital	No restriction	
Hands (herpetic whitlow)	Restrict from patient contact and contact with the patient's environment	Until lesions heal
Orofacial	Evaluate to need to restriction from care of high-risk patients	

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Human immunodeficiency virus Personnel who do not perform exposure-prone procedures Personnel who perform exposure-prone procedures	 No restriction*; refer to state regulations. Standard precautions should always be utilized Do not perform exposure-prone invasive procedures until counsel from an expert review panel has been sought; panel should review and recommend procedures the worker can perform, taking into account specific procedures as well as skill and technique of worker; standard precautions should always be observed. Refer to state and local regulations or recommendations.**	
Measles Active Postexposure (susceptible personnel)	 Exclude from duty Exclude from duty	 Until 7 days after the rash appears From 5th day after 1st exposure through 21st day after last exposure and/or 4 days after rash appears
Meningococcal infection	Exclude from duty	Until 24 hours after start of effective therapy
Mumps Active Postexposure (susceptible personnel)	 Exclude from duty Exclude from duty	 Until 9 days after onset of parotitis From 12th day after 1st exposure through 26th day after last exposure or until 0 days after onset of parotitis
Pediculosis	Restrict from patient contact	Until treated and observed to be free of adult and immature lice
Pertussis Active Postexposure (asymptomatic personnel) Postexposure (symptomatic personnel)	 Exclude from duty No restriction, prophylaxis recommended Exclude from duty	 Until 5 days after start of effective antimicrobial therapy
Rubella Active Postexposure (susceptible personnel)	 Exclude from duty Exclude from duty	 Until 5 days after rash appears From 7th day after 1st exposure through 21st day after last exposure
Scabies *Staphylococcus aureus* infection Active, draining skin lesions Carrier state	 Restrict from contact with patients and patient's environment or food handling No restriction unless personnel are epidemiologically linked to transmission of the organism	 Until lesions have resolved

Streptococcal infection, group A	Restrict from patient care, contact with patient's environment, or food handling	Until 24 hours after adequate treatment started
Tuberculosis Active disease PPD converter	 Exclude from duty No restriction	 Until proved noninfectious
Varicella Active Post exposure (susceptible personnel)	 Exclude from duty Exclude from duty	 Until all lesions dry and crust From 10th day after 1st exposure through 21st day (28th day if VZIG given) after last exposure
Zoster Localized, in healthy person Generalized or localized in immunosuppressed person Postexposure (susceptible personnel)	 Cover lesions, restrict from care of high-risk patients† Restrict from patient contact Restrict from patient contact	 Until all lesions dry and crust Until all lesions dry and crust
Viral respiratory infection, acute febrile	Consider excluding from the care of high risk patients‡ or contact with their environment during community outbreak of RSV and influenza	Until acute symptoms resolve

* Unless epidemiologically linked to transmission of infection

† Those susceptible to varicella and who are at increased risk of complications of varicella, such as neonates and immunocompromised persons of any age.

‡ High-risk patients as defined by the ACIP for complications of influenza

CDC Recommendations for Prevention and Control of Hepatitis C Virus (HCV) Infection and HCV-Related Chronic Disease. MMWR Oct 16, 1998. Vol. 47;No. RR-19:1–39

** CDC. Recommendations for preventing transmission of human immunodeficiency virus and hepatitis B virus to patients during exposure-prone invasive procedures. MMWR 1991;40(RR-8):1–8.

Appendix 4. Methods for Sterilizing and Disinfecting Patient-Care Items and Environmental Surfaces

Process*	Definition	Method		Example	Application in Health-Care	
					Patient-Care Items	Environmental Surfaces
Sterilization	Destroys all microorganisms, including bacterial spores	Heat automated	High temp	Steam, Dry heat, Unsaturated chemical vapor	Heat tolerant critical and semicritical	
			Low temp	Ethylene oxide gas, Plasma sterilization	Heat tolerant or heat sensitive critical and semicritical	Not applicable
		Liquid immersion		Chemical sterilant§ (e.g., glutaraldehyde, hydrogen peroxide, hydrogen peroxide and peracetic acid)	Heat sensitive critical or semicritical	
High-Level Disinfection	Destroys all microorganisms, but not necessarily high numbers of bacterial spores	Heat automated Liquid immersion		Washer disinfector Chemical sterilant§ (e.g., glutaraldehydes, ortho-phthalaldehyde, hydrogen peroxide)	Heat-sensitive semicritical	
Intermediate-Level Disinfection	Destroys vegetative bacteria, most fungi, and most viruses; does inactivate *Mycobacterium tuberculosis var. bovis*.¶ Not necessarily capable of killing bacterial spores	Liquid contact		Hospital disinfectant with label claim of tuberculocidal activity (e.g., chlorine-containing products, quaternary ammonium compounds with alcohol, phenolics, bromides, iodophors, EPA-registered chlorine-based product**)	Noncritical with visible blood	Clinical contact surfaces Blood spills on housekeeping surfaces
Low-Level Disinfection	Destroys most vegetative bacteria, some fungi, and some viruses. Does not inactivate *Mycobacterium tuberculosis var. bovis*.¶			• Hospital disinfectant with no label claim regarding tuberculocidal activity†† •Sanitizers (e.g., quaternary ammonium compounds, some phenolics, some iodophors)	Noncritical without visible blood	Clinical contact surfaces that are thoroughly cleaned§§ Housekeeping surfaces

* The US Environmental Protection Agency (EPA) and the US Food and Drug Administration (FDA) regulate chemical germicides used in health-care settings. The FDA regulates chemical sterilants used on critical and semicritical devices, and the EPA regulates disinfectants used on noncritical surfaces. FDA also regulates medical devices, including sterilizers. The following Internet sites can be used to obtain more information on chemical germicides and medical devices: http://www.epa.gov/oppad001/chemregindex.htm and http://www.fda.gov/cdrh/index.html and http://www.fda.gov/cdrh/ode/germlab.html.

§ Contact time is the single important variable distinguishing sterilization from high level disinfection with a liquid chemical sterilant/disinfectant agent. The FDA defines a high-level disinfectant as a sterilant used under the same contact conditions as sterilization except for a shorter immersion time (Food and Drug Administration 2000).

¶ The tuberculocidal claim is used as a benchmark to measure germicidal potency. Tuberculosis is transmitted via the airborne route rather than by environmental surfaces and, accordingly, the use of such products on environmental surfaces plays no role in preventing the spread of TB in any setting. 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 (e.g., an intermediate-level disinfectant) is considered capable of inactivating a broad spectrum of pathogens, including much less resistant organisms such as bloodborne pathogens (e.g., hepatitis B [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.

** Commercial chlorine-based products that are EPA-registered as intermediate-level disinfectants are available. In the absence of an EPA-registered chlorine-based product, a fresh solution of sodium hypochlorite (household bleach) is an inexpensive and effective intermediate-level germicide. Concentrations ranging from 500 to 800 ppm of chlorine (a 1:100 dilution of bleach and tap water or approximately ¼ cup of 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, goggles) should be worn when preparing hypochlorite solutions (OSHA 1991, Sehulster 2002). Caution should be exercised, because chlorine solutions are corrosive to metals, especially aluminum.

†† Germicides labeled as "hospital disinfectant" must pass potency tests for activity against three representative microorganisms:–*Pseudomonas aeruginosa, Staphylococcus aureus,* and *Salmonella choleraesuis*.

§§ EPA-registered low-level disinfectants that are effective against HIV and HBV.

Appendix 5. Additional Research

Although the number of published studies concerning dental infection control has increased in recent years, many questions regarding infection control practices remain unanswered. Several concerns must still be addressed by researchers in industry and by clinical investigators.

Infection Control Elements of a Personnel Health Program

1. Conduct epidemiological investigations of DHCP to determine their risk of occupationally acquired infections.

Preventing Transmission of Bloodborne Pathogens

1. Conduct prospective seroprevalence studies that will further define the risk of occupational hepatitis C infection among DHCP.
2. Develop and evaluate new devices with safety features and protective barriers.
3. Better define the epidemiology of blood contacts among DHCP and the effectiveness of prevention measures.

Transmissible Spongiform Encephalopathies

1. Determine the potential for prion infection in the oral tissues of patients with Creutzfeldt-Jacob disease (or variant CJD).

Personal Protective Equipment

1. Identify the generation of bioaersols (size, pathogen, area of contamination) during patient care procedures and the effectiveness of personal protective equipment.
2. Conduct studies to determine the efficacy of gloves related to material compatibility and duration of use.

Contact Dermatitis and Latex Hypersensitivity

1. Describe the current prevalence of irritant contact dermatitis to different chemicals in dentistry.
2. Conduct research to determine the specific protein allergens in latex.
3. Conduct research to develop latex alternative materials.

Hand Hygiene

1. Determine the most appropriate agents for hand hygiene categories.
2. Determine how antimicrobial soaps or waterless alcohol-based handrubs compare with plain (non-antimicrobial) soap in preventing transmission of organisms during routine dental procedures.
3. Assess the impact of nail polish and hand jewelry on the effectiveness of hand hygiene.
4. Study the effect of alcohol-based hand hygiene products on reducing latex proteins on the hands after latex glove usage.

Sterilization or Disinfection of Patient-Care Items

1. Investigate the applicability of other types of low-temperature sterilization procedures (e.g., hydrogen peroxide gas plasma) in dentistry.
2. Determine the appropriate barrier protection and chemical disinfection methods for heat-sensitive semicritical patient care items.
3. Determine the frequency of surface contamination on barrier-protected items (e.g., x-ray sensors, intraoral camera wands).

Environmental Infection Control

1. Explore new ways to inactivate medical waste and to minimize its volume.

Dental Unit Waterlines, Biofilm, and Water Quality

1. Determine the association between exposure to endotoxin in dental treatment water and compromised respiratory function in patients and dental health-care workers. There is currently very little data upon which to base any risk assessment for persons exposed to dental treatment water and aerosols containing large numbers of microorganisms and their associated byproducts.
2. Support research to identify safe, effective, and economical approaches to improving the quality of water used in dental treatment.

Program Evaluation

1. Develop surrogate measures (e.g., process measurements, performance indicators) for health-care-associated infections in dental settings that can demonstrate the impact of interventions (e.g., compliance, effectiveness, cost-effectiveness)
2. Develop methods for evaluating interventions.

Dental Handpieces and Other Devices Attached to Air and Waterlines

1. Determine the potential for internal contamination of low-speed handpieces, including the motor, and other devices connected to dental air and water supplies.

Single-Use Devices

1. Evaluate the effects of repetitive reprocessing cycles on burs and endodontic files.
2. Evaluate methods for removal of organic material from dental rotary instruments (e.g., carbide and diamond burs) and endodontic files.

Pre-procedural Mouth Rinses

1. Continue to assess the clinical effects of bacteremias induced by dental procedures, induced bacteremias and the possible benefits of pre-procedural mouth rinsing.
2. Conduct research to determine the effectiveness of pre-procedural mouth rinses in reducing contamination in dental aerosols and spatter.
3. Conduct research to determine the infectious disease risks associated with dental aerosols.

Surgical Procedures

1. Determine the most effective hand hygiene agents for surgical hand scrubs.
2. Further assess the effectiveness of double gloving.

Handling of Extracted Teeth

1. Further investigate the effectiveness of specific methods to disinfect/sterilize extracted teeth.
2. Determine the effects of autoclave sterilization on the dentinal structure of extracted teeth with respect to research on dental materials.

Appendix 6. Glossary of Terms

Administrative controls: the use of administrative measures (i.e., policies and procedures and enforcement measures) to reduce the risk of exposure to infectious persons.

Aerosol: particles of respirable size (<10 μm) generated by both humans and environmental sources that can remain viable and airborne for extended periods in the indoor environment; commonly generated in dentistry during use of handpieces, ultrasonic scalers, and air/water syringes.

Airborne transmission: a means of spreading infection in which airborne droplet nuclei (small-particle residue of evaporated droplets ≤ 5 μm in size containing microorganisms that remain suspended in air for long periods of time) are inhaled by the susceptible host.

Air abrasion: the application of a mixture of small abrasive particles by air blast to prepare a cavity in a tooth or remove deposits from teeth.

Alcohol-based hand rub: an alcohol-containing preparation designed for application to the hands for reducing the number of viable microorganisms on the hands. In the United States, such preparations usually contain 60-95% ethanol or isopropanol. Because these products do not remove soil, application must be preceded by a soap-and-water wash when used on soiled hands.

Allergen: an antigen, a substance capable of inducing allergy or specific hypersensitivity.

Allergic contact dermatitis(type IV [delayed] hypersensitivity): a type IV hypersensitivity resulting from contact with a chemical allergen (e.g., poison ivy, certain components of patient care gloves), generally localized to the contact area.

Anaphylaxis*:* an immediate and severe allergic reaction to a substance (e.g., food or drugs).

Antibody: a protein found in the blood that is produced in response to foreign substances (e.g., bacteria or viruses) invading the body. Antibodies protect the body from disease by binding to these organisms and destroying them.

Antigen: a foreign substance (e.g., bacteria or viruses) in the body that is capable of triggering an immune response, usually the production of antibodies.

Antibody to HBsAg (anti-HBs): an indicator of past infection with, and immunity to, hepatitis B virus, passive antibody from HBIG (hepatitis B immune globulin), or immune response from hepatitis B vaccine.

Antimicrobial soap: a soap (detergent) containing an antiseptic.

Antiseptic handwash: washing the hands with water and soap or other detergents containing an antiseptic agent.

Antiseptic hand rub: application of an antiseptic handrub product to all surfaces of the hands to reduce the number of microorganisms present.

Antiseptics: antimicrobial substances applied to the skin to reduce the number of microbial flora.

Asepsis: the absence of infection or infectious materials or agents, prevention of contact with microorganisms.

Autoclave: an instrument for sterilization using moist heat under pressure.

Asymptomatic: without symptoms, or producing no symptoms.

Bacteria: tiny one-celled organisms present throughout the environment that can be seen only with a microscope. Although not all bacteria are harmful, some cause disease.

Bacterial count: method of estimating the number of bacteria per unit sample. The term also refers to the estimated number of bacteria per unit sample, usually expressed as colony-forming units (CFUs) per square centimeter (cm^2) per milliliter (ml).

Bacterial endocarditis: a microbial infection of the endocardium or the heart valves.

Barrier material: material that prevents the penetration of microorganisms, particulates, and fluids.

Bead sterilizer (endodontic dry heat sterilizer): a device that used small glass beads (1.2–1.5 mm diameter) and high temperature (217–232^oC) for brief exposures (e.g., 45 seconds) to inactivate microorganisms.

Bioburden: the microbial or organic material on a surface or object prior to decontamination, also known as "bioload" or "microbial load."

Biofilm: microbial communities characterized by cells attached to a substrate or to each other, are embedded in a matrix of extracellular polymeric substances (glycocalyx), and exhibit increased resistance to dislodgement and the effects of antimicrobial agents.

Biological indicator: a device to monitor the sterilization process that consists of a standardized, viable population of microorganisms (usually bacterial spores) known to be resistant to the mode of sterilization being monitored. Biological indicators are intended to demonstrate whether the conditions were adequate to achieve sterilization.

Bloodborne pathogens: disease-producing microorganisms spread by contact with blood or other body fluids contaminated with blood from an infected person.

Bloodborne pathogens standard: a standard developed, promulgated, and enforced by the Occupational Safety and Health Administration (OSHA) directing employers to protect employees from occupational exposure to blood and other potentially infectious material.

Central processing or central service department: the department within a health-care facility that processes, issues, and controls professional supplies and equipment, both sterile and nonsterile, for some or all patient care areas.

Chemical indicator: a material containing a chemical that changes color or form with exposure to heat, steam, or ethylene oxide; used to monitor exposure of items to heat- or gas-sterilizing agents.

Chemical sterilant: chemicals used for the purpose of destroying all forms of microbial life including fungal and bacterial spores.

Cleaning: the removal of visible soil and organic contamination from a device or surface, using either the physical action of scrubbing with a surfactant or detergent and water or an energy-based process (e.g., ultrasonic cleaners) with appropriate chemical agents.

Clinical contact surface: environmental surfaces that are directly contacted or touched by 1) contaminated instruments, devices, and dental materials; 2) contaminated hands or gloves; or 3) droplet and spatter generated during patient care (e.g., light handles, switches on the dental chair).

Colony: a mass of cells that originated from one cell or one colony-forming unit.

Colony-forming unit (CFU): the original cells that begin multiplication to form a

colony. The minimum number of separable cells on the surface of or in semi-solid agar medium which gives rise to a visible colony of progeny is on the order of tens of millions. CFUs may consist of pairs, chains, and clusters as well as single cells and are often expressed as colony-forming units per milliliter (CFU/ml).

Contaminant: substance that results in impurity by contact or mixture.

Contaminated: state of having been actually or potentially in contact with microorganisms. As used in health care, it generally refers to microorganisms that could be capable of producing disease or infection.

Control biological indicator: a biological indicator from the same lot as a test indicator that is left unexposed to the sterilization cycle and then incubated to verify the viability of the test indicator. The control indicator should yield positive results for bacterial growth.

Creutzfeldt-Jakob disease (CJD): an infectious degenerative neurological disorder of humans thought to be transmitted by abnormal isoforms of neural proteins called prions. CJD is one of a group of related diseases known as transmissible spongiform encephalopathies (TSEs).

Critical items: dental instruments or devices that penetrate normally sterile areas of the mouth (e.g., soft tissue, contact bone, enter into or contact the bloodstream).

Decontaminate hands: To reduce bacterial counts on hands by performing antiseptic hand rub or antiseptic handwash.

Decontamination: A process or treatment that renders a medical device, instrument, or environmental surface safe to handle.

Dental health-care personnel: all paid and unpaid personnel in the dental health-care setting who have the potential for exposure to infectious materials, including body substances and contaminated supplies, equipment, environmental surfaces, water, or air.

Dental treatment water: Nonsterile water used for dental therapeutic purposes, including irrigation of nonsurgical operative sites and cooling of high speed and ultrasonic instruments.

Dental unit waterlines: Small bore tubing, usually plastic, used to deliver dental treatment water through a dental unit.

Detergents: compounds that possess a cleaning action and have hydrophilic and lipophilic parts. Although products used for handwashing or antiseptic handwash in a health-care setting represent various types of detergents, the term “soap” is used to refer to such detergents in this guideline.

Disinfectant*:* a chemical agent used on inanimate objects to destroy virtually all recognized pathogenic microorganisms, but not necessarily all microbial forms (e.g., bacterial spores).

Disinfection: a process of microbial inactivation, generally less lethal than sterilization, that eliminates virtually all recognized pathogenic microorganisms but not necessarily all microbial forms (e.g., bacterial spores).

Distilled water: water heated to the boiling point, vaporized, cooled, condensed, and collected so that no impurities are reintroduced.

Droplet nuclei: small pathogen-containing particles of respiratory secretions expelled into the air by coughing, which are reduced by evaporation to small dry particles that

can remain airborne for long periods; one possible mechanism for transmission of infection from one individual to another.

Droplets: small particles of moisture that may be generated when a person coughs or sneezes or when water is converted to a fine mist by an aerator or shower head. Intermediate in size between drops and droplet nuclei, these particles, tend to quickly settle out from the air so that any risk of disease transmission is generally limited to persons in close proximity to the droplet source.

Dry heat sterilizer: an instrument for sterilizing with heated air.

Endotoxin: the lipopolysaccharides found in the cell walls of Gram-negative bacteria, whose toxic character resides in their lipid portion. Endotoxins can produce pyrogenic reactions in exposed persons.

Engineering controls: controls that isolate or remove a hazard from the workplace.

Event-related packaging: a storage practice that recognizes that a package and its contents should remain sterile until some event causes the item(s) to become contaminated.

Exposure: the condition of being subjected to something (e.g., an infectious agent) that could have a harmful effect.

Exposure time: period of time during a sterilization process in which items are exposed to the sterilant at the specified parameters. In steam sterilization, exposure time is the period in which items are exposed to saturated steam at the specified temperature.

Flash steam sterilization: process designed for the steam sterilization of unwrapped critical patient care items for immediate use.

Germicide: a chemical agent manufactured for the purpose of destroying microorganisms. Some chemicals indicate the type of microorganism destroyed (prefix), with the use the suffix "-cide" (e.g., virucide, fungicide, bactericide, sporicide, tuberculocide).

Glycocalyx: the polysaccharide material produced by bacteria that forms the structural matrix of biofilm.

Hand antisepsis*:* refers to either antiseptic handwash or antiseptic hand rub. A process for the removal of soil and transient microorganisms from the hands.

Hand hygiene: a general term that applies to handwashing, antiseptic handwash, antiseptic hand rub, and surgical hand antisepsis.

Handwashing*:* washing hands with plain (non-antimicrobial) soap and water.

Health-care personnel*:* all paid and unpaid persons working in health-care settings who have the potential for exposure to infectious materials, including body substances, and contaminated medical (including dental) equipment and supplies, environmental surfaces, or air.

Health-care-associated infection: any infection associated with a medical or surgical intervention. The term “healthcare-associated” replaces “nosocomial,” which is limited to adverse infectious outcomes occurring in hospitals.

Hepatitis B surface antigen (HBsAg): surface antigen(s) of hepatitis B virus detectable in large quantity in serum of infected persons.

Hepatitis B e antigen (HBeAg): antigen correlates with hepatitis B virus replication, as a marker of increased infectivity.

Heterotrophic bacteria: those bacteria that require an organic carbon source for growth, i.e., they derive energy and carbon from organic compounds. The modifier

"mesophilic" describes bacteria that grow best within the middle ranges of environmental temperature.

Heterotrophic plate count bacteria (HPC bacteria): bacteria that can be grown on non-selective heterotrophic agar plates.

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

Housekeeping surfaces: environmental surfaces (e.g., floors, walls, ceilings) not involved in direct delivery of patient care in health-care facilities.

Hypersensitivity*:* a condition in which the body has an exaggerated response to a substance (e.g., food or drug). Also known as allergy.

Iatrogenic: describes an infectious disease or other complication resulting from medical or dental treatment.

Immunity: protection against a disease. Indicated by the presence of antibodies in the blood, immunity can usually be determined by a laboratory test.

Immunization: The process by which a person becomes immune, or protected, against a disease. This term is often used interchangeably with vaccination or inoculation.

Immunoglobulin (Ig): a protein that functions as an antibody in the blood that fights infection.

Implantable device: according to the Food and Drug Administration (FDA), "device that is placed into a surgically or naturally formed cavity of the human body if it is intended to remain there for a period of 30 days or more" [21 CFR 812.3(d)].

Independent water reservoir: A container used to hold water or other solutions and supply it to handpieces and air/water syringes attached to a dental unit. The independent reservoir, which isolates the unit from the public water system, may be provided as original equipment or as a retrofit device on all modern dental units.

Infectious microorganisms: microorganisms capable of producing infection in susceptible hosts.

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

Irritant contact dermatitis: the development of dry, itchy, irritated areas on the skin, which can result from frequent handwashing and gloving as well as exposure to chemicals.

Latex allergy (type I [immediate] hypersensitivity): a systemic immune reaction to the proteins found in natural rubber latex.

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

Low-level disinfection: a process that will inactivate most vegetative bacteria, some fungi, and some viruses but cannot be relied on to inactivate resistant microorganisms (e.g., mycobacteria or bacterial spores).

Mechanical indicator: automated devices (e.g., graphs, gauges, printouts) that monitor the sterilization process.

Medical waste: waste sufficiently capable of causing infection during handling and disposal (e.g., pathology and anatomy waste, blood, other body fluid specimens) to merit special handling and disposal.

Mesophilic: that which favors a moderate temperature. For mesophilic bacteria, a temperature range of 20–55°C (68–131°F) is favorable for growth and proliferation.

Microfilter: Membrane filter used to trap microorganisms suspended in water. Filters are usually installed on dental unit waterlines near the point of use as a retrofit device. Microfiltration commonly occurs at 0.03 to 10 μm. Sediment filters commonly found in dental unit water filter regulators range from 20 to 90 μm and do not function as microbiological filters.

Microorganisms: As used in health care, the term generally refers to bacteria, fungi, viruses, and bacterial spores of microscopic size.

N-95 respirator: NIOSH (National Institute of Occupational Safety and Health)-certified respirator that meets minimum filtration performance criteria for respiratory protection in TB areas.

Noncritical devices or items: these medical devices or surfaces come into contact with only intact skin. The risk of infection from using these devices is low.

Nosocomial: describes an infection acquired in a hospital as a result of medical care (see definition for health-care-associated infection).

Occupational exposure: blood or other potentially infectious material that contact either parenterally or the skin, eye, or mucous membrane during the performance of an employee's duty.

Occupational and environmental health service: a medical practice that specializes in recognizing and resolving workplace hazards and treating job-related diseases. The practitioner can assist a dental office in developing an exposure control plan and in implementing postexposure management protocols.

Opportunistic infection: an infection caused by a microorganism that does not ordinarily cause disease but does, under certain host conditions (e.g., impaired immune response).

Particulate respirator: a respirator that removes small particles from the air. Several types of particulate respirators are available for use against tuberculosis (e.g., N-95).

Parts per million (ppm): a measure of concentration in solution. A 5.25% chlorine bleach solution (undiluted as supplied by the manufacturer) contains approximately 50,000 parts per million of free available chlorine.

Percutaneous injury: an injury that penetrates the skin (e.g., needlestick, or cut with a sharp object).

Performance criteria: the measure for judging how well a function operates as expected for its intended patient care purpose.

Persistent activity: the prolonged or extended activity that prevents or inhibits the proliferation or survival of microorganisms after application of the product. This activity may be demonstrated by sampling a site several minutes or hours after application and demonstrating bacterial antimicrobial effectiveness when compared with a baseline level. In the past, this property was also called "residual activity." Both substantive and non-substantive active ingredients can show a persistent antimicrobial effect if they lower the number of bacteria significantly during the handwashing period.

Personal protective equipment (PPE): the specialized clothing or equipment worn by an employee for protection against a hazard (e.g., gloves, mask, eyewear, gown).

Plain or non-antimicrobial soap*:* detergents that do not contain antimicrobial agents or contain very low concentrations of such agents that are effective solely as preservatives.

Planktonic: free-floating or weakly swimming organisms suspended in a bulk fluid.

Postexposure prophylaxis: the administration of medications following an occupational exposure in an attempt to prevent infection.

Potable (drinking) water: water suitable for drinking per applicable public health standards.

Pre-procedural mouth rinse: a mouth rinse used before a dental procedure to reduce the number of microorganisms.

Prion: a modified form of a normal cell surface component known as a prion protein, a pathogenic form of the protein that is both less soluble and more resistant to enzyme degradation than the normal form. It is associated with the transmission of diseases known as transmissible spongiform encephalopathies (TSEs).

Pyrogen: a fever-producing substance such as bacterial endotoxin (lipopolysaccharide).

Qualified health-care professional: any health care provider who can provide counseling and perform all medical evaluations and procedures in accordance with the most current recommendations of the US Public Health Service, including postexposure prophylaxis when indicated.

Reprocessing (of medical or dental instruments): the procedures or steps taken to make a medical or dental instrument safe for use on the next patient. Reprocessing encompasses both cleaning and the final or terminal step (i.e., sterilization or disinfection), which is determined by the intended use of the instrument.

Reservoir of infection: an alternate or passive living host or inanimate carrier that harbors pathogenic microorganisms without harm to itself and serves as a source from which persons or animals can be infected.

Resident flora*:* species of microorganisms that are always present on or in the body and are not easily removed by mechanical friction.

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

Sanitizer: an agent that reduces microbial contamination to safe levels as judged by public health standards or requirements.

Semicritical items: dental instruments and devices that come into contact with mucous membranes but do not penetrate normally sterile areas of the mouth (e.g., soft tissue, bone, bloodstream).

Single-use (disposable) device: a device intended to be used on one patient and then discarded appropriately. These items are not intended to be reprocessed (cleaned, disinfected, or sterilized) and used on another patient.

Spatter: visible drops of liquid or body fluid that are expelled forcibly into the air and settle out quickly, as distinguished from particles of an aerosol, which remain airborne indefinitely.

Standard precautions: A set of combined precautions that include the major components of universal precautions (designed to reduce the risk of transmission of bloodborne pathogens) and body substance isolation (designed to reduce the risk of

transmission of pathogens from moist body substances). Similar to universal precautions, standard precautions are used for care of all patients regardless of their diagnosis or presumed infection status.

Steam sterilization: sterilization process that uses saturated steam under pressure as the sterilizing agent for a specified exposure time and at a specified temperature.

Sterilant: an agent that destroys all forms of microbiological life, including fungal and bacterial spores.

Sterile/sterility: state of being free from all living microorganisms. In practice, usually described as a probability function, e.g., the probability of a surviving microorganism being 1 in 1,000,000.

Sterile water: water that is sterilized and contains no antimicrobial agents.

Sterilization: the use of a physical or chemical procedure to destroy all microbial life, including bacterial endospores.

Sterilizer, gravity-displacement type: type of steam sterilizer in which incoming steam displaces residual air through a port or drain in or near the bottom (usually) of the sterilizer chamber. In most table-top sterilizers in dental offices, the steam is generated by heating a measured amount of water introduced into the bottom of the sterilization chamber.

Sterilizer, pre-vacuum type: type of steam sterilizer that depends upon one or more pressure and vacuum excursions at the beginning of the cycle to remove air and draw in saturated steam produced by a separate steam generator.

Surfactants*:* surface-active agents that reduce surface tension, they make water "wetter." They also help cleaning by loosening, emulsifying, and holding soil in suspension, which can then be more readily rinsed away. Can be classified by their net ionic charge, as anionic (negative), cationic (positive) or nonionic (none).

Surgical hand antisepsis: antiseptic handwash or antiseptic hand rub performed preoperatively by surgical personnel to eliminate transient flora and reduce resident hand flora. Antiseptic detergent preparations often have persistent antimicrobial activity.

Surgical hand scrub*:* an antiseptic-containing preparation that substantially reduces the number of microorganisms on intact skin; it is broad-spectrum, fast–acting, and persistent.

Surgical procedure: procedure involving the incision, excision, or reflection of skin or oral mucosa that exposes the normally sterile areas of the oral cavity. Examples include biopsy, periodontal surgery, apical surgery, and extractions of teeth.

Transient flora: microorganisms that may be present in or on the body under certain conditions and for certain lengths of time; they are more amenable to removal by mechanical friction than resident flora.

Transmissible spongiform encephalopathies (TSEs): a group of rapidly progressive, invariably fatal, degenerative neurological disorders affecting both humans and animals that are caused by infection with prions.

Transmission-based precautions: a set of practices that apply to patients with documented or suspected infection or colonization with highly transmissible or epidemiologically important pathogens for which precautions beyond the standard precautions are needed to interrupt transmission in health-care settings.

Tuberculin skin test (TST): a method used to evaluate the likelihood that a person is infected with *M. tuberculosis*.

Tuberculosis infection, latent: a condition in which living tubercle bacilli (*M. tuberculosis)*are present in the body but the disease is not clinically active. Infected persons usually have positive tuberculin skin test, but they have no symptoms related to the infection and are not infectious. Infected persons remain at lifelong risk for developing disease, however, if they are not given preventive therapy.

Turbidity: cloudiness.

Ultrasonic cleaner: a 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.

Unsaturated chemical vapor sterilizer: an instrument for sterilization that uses hot ethyl alcohol and formaldehyde vapors under pressure.

Vaccination: inoculation with a vaccine.

Vaccine: a suspension of infectious agents or some part of them, given for the purpose of establishing resistance to an infectious disease.

Vegetative bacteria: a state of quiescence, which is achieved when certain bacteria (i.e., gram-positive bacilli) are resting. Denotes the portion of a cell cycle during which the cell is not involved in replication.

Ventilation: the process of supplying and removing air by natural or mechanical means to and from any space; such air may be conditioned.

Washer disinfector: an automatic unit designed to clean and thermally disinfect instruments. The unit uses a high-temperature cycle rather than a chemical bath.

Waterless antiseptic agent: An antiseptic agent that does not require use of exogenous water. After applying such an agent, the person rubs the hands together until the agent has dried.

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

Work practice controls: controls that reduce the likelihood of exposure by altering the manner in which a task is performed (e.g., recapping of needles using a “scoop technique” instead of two hands).