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Infection control

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Preventing disease transmission is the primary goal of infection control. Evidence-based strategies for disease prevention and risk reduction comprise the foundation for an effective program. Policies, procedures, and practices are designed to prevent work-related injuries and infections in dental health care personnel (DHCP) and health care-associated infections in patients. Site-specific standard operating procedures facilitate DHCP in the day-to-day implementation of the program.

Rationale for infection control

Several key concepts support the rational for the need for infection control:

- Because of the nature of dental care, patients and DHCP have the potential for exposure to a variety of microorganisms in dental health care settings. Some of these microorganisms are or have the potential to be pathogenic in humans.
- Microorganisms may be transmitted in health care settings (including dental health care settings) through several routes, including (1) direct contact with blood, saliva, and other oral fluids, or other body fluids; (2) indirect contact with contaminated instruments, operatory equipment, or environmental surfaces; and (3) contact with airborne contaminants present either in droplets (eg, spatter) or in aerosolization of microorganisms that can remain suspended for long periods of time [1].
- After a route of transmission is established, the ''chain'' of infection must be complete and intact for infection to occur [2]. The chain of infection requires (1) a pathogenic organism of sufficient virulence and in adequate numbers (ie, dosage) to cause disease; (2) a suitable reservoir or source that allows the pathogen to survive and multiply (eg,

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blood); (3) a mechanism of transmission from the source to the host; (4) a portal of entry through which the pathogen may enter the host; and (5) a susceptible host (ie, nonimmune individual).

- Infection control strategies (policies, procedures, and practices) are intended to break one or more of these "links" in the chain, thereby preventing infection. Such strategies include immunizations; hand hygiene and personal and environmental barrier techniques; effective cleaning, disinfection, and sterilization procedures; and aseptic techniques and practices to reduce the risk of exposure to blood, other body fluids, or infectious agents [1].

Infection control precautions

Infection control precautions consist of policy, procedure, and practice strategies that are designed to prevent health care-associated infections in health care personnel and patients. Previous Centers for Disease Control and Prevention (CDC)–established infection control precautions recommendations are recognized as a standard of care in the United States. In the 1980s and into the early 1990s, the CDC primarily focused on the use of "universal precautions," or blood and body fluid precautions, to reduce the risk of transmission of bloodborne pathogens among health care personnel and patients [3–6]. Rationale for universal precautions arises from the fact that many persons with bloodborne infections cannot be identified due to subclinical and undiagnosed infections. These recommendations emphasized the need to treat blood and other body fluids contaminated with blood from all patients as potentially infectious [3–8].

In 1996, the CDC combined the major components of universal (blood and body fluid) precautions (designed to reduce the risk of transmission of bloodborne pathogens) and "body substance isolation precautions" (designed to reduce the risk of transmission of pathogens from moist body substances) into one set of precautions known as "standard precautions" [9]. Standard precautions apply to blood; to all body fluids, secretions, and excretions except sweat, regardless of whether they contain visible blood; to nonintact skin; and to mucous membranes [1]. Standard precautions are designed to reduce the risk of transmission of microorganisms from both recognized and unrecognized sources of infection. As such, standard precautions assume all patients are potentially infectious with a variety of pathogenic microorganisms. Elements of standard precautions are then determined by the infectious exposure risks of a procedure.

Standard precautions, put simply, are procedure-specific precautions rather than patient-specific precautions. DHCP may decide to wear two pair of gloves (double glove) for a surgical procedure. The decision to double glove is based on the duration of the procedure and the anticipated exposure to blood, not the known or perceived infectious serostatus of the patient.

Standard precautions are considered adequate for most infectious diseases [1]. Additional precautions known as "transmission-based precautions" are necessary for interrupting the spread of certain pathogens such as tuberculosis, influenza, and chicken pox that are transmitted by air, droplet, and indirect or direct contact with contaminated sources [1,9]. These precautions include a variety of strategies beyond standard precautions, including ventilation requirements, special respiratory protection for health care personnel, postponement of nonemergent dental procedures, and other measures [1].

Exposure prevention

Primary methods used to prevent occupational exposures to infectious agents in dental health care settings include engineering and work practice controls and the use of personal protective equipment.

Engineering controls reduce exposure either by removing, eliminating, or isolating the infectious hazard. These controls are frequently technology based and often incorporate safer designs of instruments and devices. Whenever possible, engineering controls should be used as the primary method to reduce exposures to bloodborne pathogens by sharp instruments and needles. Studies suggest that devices such as self-sheathing anesthetic needles and dental units designed to shield burs in handpieces may reduce percutaneous injuries [10–12].

Work practice controls are behavior-based and are intended to reduce the risk of exposure by changing the manner in which a task is performed. Specific work practices must be provided to protect personnel whose responsibilities include handling, using, assembling, or processing contaminated patient care items and devices and environmental surfaces [6,13,14].

Spaulding classification scheme—patient care instruments, devices, and environmental surfaces

Cleaning, disinfection, and sterilization of patient care items and surfaces are integral components of an infection control program. DHCP should have an understanding of the science behind these processes and their application.

In 1968, Earle H. Spaulding devised a logical approach to disinfection and sterilization of patient care instruments and equipment [2,15,16]. Based on the risk of transmitting infection during use, Spaulding described three categories of instruments and devices and the level of sterilization/disinfection necessary for the safe use of each category: critical, semicritical, and noncritical [2,17]. Table 1 summarizes how these categories apply to processing patient care items.

Table 1
Categories of patient care items and environmental surfaces

Category	Definition	Equipment examples
Critical		
Patient care items	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		
Patient care items	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[a]
Noncritical		
Patient care items	Contact with intact skin	Blood pressure cuff, stethoscope, pulse oximeter
Environmental surfaces		
Clinical contact	Dental equipment surfaces[b] that are directly contacted by contaminated instruments, devices, dental materials, hands, or gloves	Light handles, switches on dental equipment, drawer handles, dental radiograph equipment, countertops
Housekeeping	Surfaces that require regular cleaning and removal of soil and dust	Floors, walls, sinks

[a] Although considered a semicritical item, heat sterilization is recommended. See the specific equipment and device manufacturer's instructions for detailed processing information for dental handpieces and other devices attached to air and/or waterlines.

[b] Nonclinical surfaces (eg, pencil, telephone handle, doorknob) inadvertently contacted with a contaminated hand/glove also should be cleaned and disinfected after patient treatment.

Modified from CDC Guideline for infection central in dental health-care settings. Atlanta (GA): Centers for Disease Control; 2003, in press; with permission.

In 1991, the Spaulding noncritical category was expanded to include environmental surfaces to define more clearly the relative risk of disease transmission by these surfaces [2]. Noncritical environmental surfaces carry the least risk of disease transmission. Environmental surfaces can be further divided into clinical-contact surfaces and housekeeping surfaces (see Table 1).

In the United States, only those products and devices cleared for market by the United States Food and Drug Administration (FDA) as medical devices sterilizers and chemical sterilants/high level disinfectants should be used to process critical and semicritical patients care items. Only those chemical agents registered with the United States Environmental Protection Agency (EPA) as hospital-grade germicides should be used in health care settings for the decontamination of noncritical patient care items and clinical-contact environmental surfaces. Manufacturers of products and materials should provide information regarding materials compatibility with chemical germicides, whether or not the equipment can be safely immersed

for cleaning, and how the equipment should be decontamintated or protected with environmental surface barriers and covers [13]. A summary of sterilization and disinfection methods is described in Table 2.

Infection control program development

An infection control program has several core elements:

- An infection control health services program for health care personnel
- Exposure prevention strategies including selection and use of engineering controls and safe work practices
- Hand hygiene
- Personal barrier protection
- Infection control management of patient care instruments and devices
- Environmental infection control
- Program evaluation/program quality

These elements provide the broad template for developing an individualized infection control program. Each of the elements has fundamental policy and procedure components that are common to most health care settings. The procedure- and device-specific issues of each element vary in the area of health care services and, to some degree, in the setting (eg, ambulatory versus hospital). Dental health care settings are primarily in ambulatory care settings.

The component content area for each of the core elements is determined by (1) a systematic review of the literature, including guidelines and recommendations of the CDC; (2) relevant regulations and statutes at the federal, state, and local levels; (3) information regarding technology and techniques from the scientific literature; (4) professional recommendations and resources; and (5) setting-specific considerations.

Guidelines and recommendations from the CDC set the basis for a standard of care in infection control in the United States. Guidelines are developed in a systematic manner and reflect current scientific evidence and expert analysis. In 1993, the CDC published *Recommended Infection Control Practices for Dentistry* [6], which is currently being revised and is scheduled for publication in the fall of 2003. Dentistry-specific recommendations provide direct guidance for dental health care settings. Other CDC guidelines for health care settings also have implications for dentistry (Table 3). CDC guidelines are accessible electronically on the CDC Web site at http://www.cdc.gov/ncidod/hip/. The revised guideline for infection control in dental health care settings will be available at this site when it is officially published in *Morbidity and Mortality Weekly Report*.

CDC guidelines and recommendations (and in particular, specific recommendations for dentistry) form the foundation of any infection control program. The CDC Division of Oral Health (http://www.cdc.gov/OralHealth/infection_control/index.htm) provides such dental-specific information.

Table 2
Methods for sterilization or disinfection

Process[a]	Definition	Method	Example	Application in healthcare	
				Patient care items	Environmental surfaces
Sterilization	Destroys all microorganisms including bacterial spores	Heat automated High temperature	Steam (gravity; prevacum)	Critical and heat-tolerant semicritical	
			Dry heat (static; convection)	Critical and heat-tolerant or -sensitive semicritical	Not applicable
			Unsaturated chemical vapor		
		Low temperature	ETO, Plasma sterilization		
		Liquid immersion	Chemical sterilant[b] (eg, glutaraldehydes, hydrogen peroxide, hydrogen peroxide and peracetic acid)	Heat-sensitive critical or semicritical	
High-level disinfection	May destroy all microorganisms but not necessarily high numbers of bacterial spores	Heat automated	Washer disinfector	Heat-sensitive semicritical	Not applicable
		Liquid immersion	Chemical sterilant[b] (eg, glutaraldehydes, ortho phthalaldehyde, hydrogen peroxide)		
Intermediate-level disinfection	May destroy vegetative bacteria, most fungi, and most viruses; inactivates *Mycobacterium tuberculosis var bovis* Not necessarily capable of killing bacterial spores	Liquid contact	Hospital disinfectant with tuberculocidal activity label claim[c] (eg, chlorine-containing products, quaternary ammonium compounds with alcohol, phenolics, bromides, iodophors, household bleach[d])	Noncritical with visible blood	Clinical contact surfaces
					Blood spills on clinical contact or housekeeping surfaces

Low-level disinfection	May destroy most vegetative bacteria, some fungi, and some viruses. Does not inactivate *Mycobacterium tuberculosis var bovis*	Liquid contact	Sanitizers[e] (eg, quaternary ammonium compounds, some phenolics, some iodophors)[f]	Noncritical with no visible contamination/blood	Clinical contact surfaces House keeping surfaces

Abbreviation: ETO, Ethylenediamine-tetraacetic acid.

[a] 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. The 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.

[b] Contact time is the single most important variable between sterilization and 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 except for a shorter immersion time than for sterilization. The following Internet site can be used to obtain more information: http://www.fda.gov/cdrh/ode/397.pdf.

[c] The tuberculocidal claim is used as a benchmark to measure germicidal potency. Tuberculosis is transmitted by way of 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 tuberculosis in any setting. Because mycobacteria have among the highest intrinsic level of resistance among the vegetative bacteria, viruses, and fungi, any germicide with a tuberculocidal claim on the label (eg, an intermediate-level disinfectant) is considered capable of inactivating a broad spectrum of pathogens including much less resistant organisms such the bloodborne pathogens (eg, hepatitis B virus, hepatitis C virus, 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.

[d] Although not registered with the EPA as a disinfectant, a fresh solution of sodium hypochlorite (household bleach) prepared daily 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 2 oz of bleach to 1 gal of water) are effective on environmental surfaces that have been cleaned of visible contamination. Appropriate personal protective equipment (eg, gloves, goggles) should be worn when preparing hypochlorite solutions [13,18]. Commercial chlorine-based products that are EPA registered as intermediate-level disinfectants are available. Caution should be exercised because chlorine solutions are corrosive to metals, especially aluminum.

[e] Germicides labeled as "hospital disinfectant" must pass potency tests for activity against three representative microorganisms: *Pseudomonas aeruginosa, Staphylococcus aureus*, and *Salmonella cholerasuis*.

[f] EPA-registered low-level disinfectant with label claim against HIV and hepatitis B virus.

Modified from CDC. Guideline for infection control in dental health-care settings. Atlanta (GA): Centers for Disease Control and Prevention; 2003, in press; with permission.

Table 3
Published guidelines for infection control in health care settings, with specific implications for dental health care settings

Document title	Year	Reference
"Guidelines for Handwashing and Hospital Environmental Control"	1985	[8]
"Recommendations for Preventing Transmission of Human Immunodeficiency Virus and Hepatitis B Virus to Patients During Exposure-prone Invasive Procedures"	1991	[19]
"Guidelines for Preventing the Transmission of *Mycobacterium tuberculosis* in Health-care Facilities"	1994	[20]
"Guideline for Hand Washing and Hand Antisepsis in Health-care Settings"	1995	[21]
"Guideline for Isolation Precautions in Hospitals"	1996	[9]
"Guideline for Selection and Use of Disinfectants"	1996	[22]
"Immunization of Health-care Workers"	1997	[23]
"Guideline for Infection Control in Health-care Personnel"	1998	[1]
"Guideline for Prevention of Surgical Site Infection"	1999	[24]
"Updated US Public Health Service Guidelines for the Management of Occupational Exposures to HBV, HCV, and HIV and Recommendations for Postexposure Prophylaxis"	2001	[25]
"Guidelines for Environmental Infection Control in Health-care Facilities"	2003	[18]
"Guideline for Cleaning, Disinfection, and Sterilization in Health-care Facilities"	in press	[26]
"Guideline for Hand Hygiene in Health-care Settings"	2002	[27]
"Guideline for Infection Control in Dental Health-care Settings"	2003	[In press]

Abbreviations: HBV, hepatitis B virus; HCV, hepatitis C virus.
Adapted from http://www.cdc.gov/ncidod/hip/.

CDC is not a regulatory agency, and the guidelines and recommendations are not specifically regulated unless an individual state adopts, in whole or in part, CDC guidelines as regulation. Other agencies at the federal, state, and local level, however, regulate various aspects of infection control in health settings.

The Occupational Safety and Health Agency (OSHA) of the United States Department of Labor develops standards for workplaces and regulates employers to help assure safe and healthful working conditions in places of employment in the United States. The most commonly cited OSHA regulation in the professional dental literature is the Bloodborne Pathogens Standard (1910.1030, 1991) [13] and revisions that took effect in 2001. Other standards apply to dental health care settings and can be found on OSHA's Web site at http://www.osha.gov/SLTC/dentistry/index.html.

Some states have federally recognized state OSHA programs. In these states, standards must minimally meet the federal OSHA standard but may

exceed the standard in regulation scope and stringency. Health care settings in these states must comply with the state-specific standard. Links to the state OSHA programs are available at www.osha.gov.

The FDA (www.fda.org) regulates food, drugs, medical devices, biologics, and radiologic agents and devices [28]. Safety and efficacy requirements are used to clear products and devices for market to the public. A variety of products that impact the practice of dentistry and infection control is regulated by FDA. Some of the dental devices that are regulated by FDA include medical gloves, face masks, sterilizers, sterilization packaging material, sterilization process indicators, biologic indicators, sharps devices with engineered safety features, chemical sterilants, and other medical devices and adjuncts to devices.

The EPA is another regulatory agency. The EPA's mission is to protect human health and to safeguard the natural environment—air, water, and land. EPA develops and enforces regulations that implement environmental laws enacted by Congress. The EPA is responsible for researching and setting national standards for a variety of environmental programs [29].

The EPA regulates and registers disinfectants used for infection control in health care settings (eg, hospital-grade disinfectants). A list of EPA-registered disinfectants is available on the EPA Web site at http://www.epa.gov/oppad001/chemregindex.htm.

The CDC does not regulate, test, evaluate, or recommend specific brand-name products or devices for infection control in dental health care settings; however, it does provide recommendations and guidance on application of EPA- and FDA-regulated products and devices.

State and local regulations impact various components of an infection control program. Each state may vary in the agency and scope of regulatory authority in the area of infection control. The following are examples of state and local agencies:

- Department of Public Health and health departments
- Department of Environmental Protection
- Department of Waste Water Resources
- Boards of registration and licensure
- Other specific state and local agencies

Professional organizations disseminate topic- and profession-specific information through newsletters, journal publications, Web-based information, education programs, and position papers. Professional journals can be a source of published scientific infection control information. Professional organizations may also provide input in the development of guidelines and regulations.

Table 4 provides a sample list of Web-based infection control resources. These resources provide specific information from the organization and agency, as well as links to related information.

Table 4
Web-based infection control resources

Resource	Web site
Advisory Committee on Immunization Practices	http://www.cdc.gov/nip/ACIP/default.htm
American Dental Association	http://www.ada.org/
American Institute of Architects Academy of Architecture for Health	http://www.aahaia.org
American Society of Heating, Refrigeration, Air-conditioning Engineers	http://www.ashrae.org
Association for Professionals in Infection Control and Epidemiology, Inc.	http://www.apic.org/resc/guidlist.cfm
CDC Division of Health Care Quality Promotion	http://www.cdc.gov/ncidod/hip/
CDC Division of Oral Health, Infection Control	http://www.cdc.gov/OralHealth/infectioncontrol/index.htm
CDC Morbidity and Mortality Weekly Report	http://www.cdc.gov/mmwr/
CDC Recommends...Prevention Guidelines System	http://www.phppo.cdc.gov/cdcRecommends/AdvSearchV.asp
Environmental Protection Agency	http://www.epa.gov/oppad001/chemregindex.htm
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
CDC National Institute for Occupational Safety and Health	http://www.cdc.gov/niosh/homepage.html
Occupational Safety and Health Administration, Dentistry	http://www.osha.gov/SLTC/dentistry/index.html
Organization for Safety and Asepsis Procedures	http://www.osap.org/
Society for Health Care Epidemiology of America, Inc.	http://www.shea-online.org/PositionPapers.html

Infection control program evaluation

The primary goal of an infection control program is to provide a safe working environment that will reduce the risk of health care-associated infections among patients and occupational exposures among DHCP.

A secondary goal is compliance with existing CDC recommendations, federal, state, and local regulations, and professional standards of care.

Evaluation is an ongoing and dynamic process of collecting and analyzing information and refining policies, procedures, and practices. Examples of infection control information used for program evaluation include

- Appropriate immunization of DHCP
- DHCP adherence to hand hygiene policies
- Appropriate use of personal barrier protection
- Observation of DHCP work practices and compliance with written policies and procedures

- Documentation of monitored procedures and technologies (eg, biologic monitoring of sterilization; dental unit water quality monitoring)
- Surveillance of work-related injuries and illnesses in DHCP
- Health care–associated infections in patients

Summary

Information resources from a variety of governmental agencies and professional organizations are available to facilitate development of site-specific infection control programs. Using a strategic approach to organize and apply the information can result in a comprehensive and effective infection control program.

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