Infection Control for Dental Professionals

HOW TO RECEIVE CREDIT

- Read the enclosed course.
- Complete the questions at the end of the course.
- Return your completed Answer Sheet to NetCE by mail or fax, or complete online at www.NetCE.com. Your postmark or facsimile date will be used as your completion date.
- Receive your Certificate(s) of Completion by mail, fax, or email.

Faculty

Mark J. Szarejko, DDS, FAGD, received his dental degree from the State University of New York at Buffalo in 1985. He received fellowship from the Academy of General Dentistry in 1994.

Faculty Disclosure

Contributing faculty, Mark J. Szarejko, DDS, FAGD, has disclosed no relevant financial relationship with any product manufacturer or service provider mentioned.

Senior Director of Development and Academic Affairs

Sarah Campbell

Director Disclosure

The director has disclosed no relevant financial relationship with any product manufacturer or service provider mentioned.

Audience

This course is designed for all dentists, dental hygienists, and dental assistants in all practice settings.

Accreditations & Approvals

NetCE is an ADA CERP Recognized Provider.

ADA CERP is a service of the American Dental Association to assist dental professionals in identifying quality providers of continuing dental education. ADA CERP does not approve or endorse individual courses or instructors, nor does it imply acceptance of credit hours by boards of dentistry.

Concerns or complaints about a CE provider may be directed to the provider or to ADA CERP at www.ada.org/cerp.

PACE ACADEMY of GENERAL DENTISTRY PROGRAM APPROVAL FOR CONTINUING EDUCATION

NetCE
Nationally Approved PACE Program Provider for FAGD/MAGD credit.
Approval does not imply acceptance by any regulatory authority or AGD endorsement.
10/1/2021 to 9/30/2027
Provider ID #217994.

NetCE is a Registered Provider with the Dental Board of California. Provider number RP3841. Completion of this course does not constitute authorization for the attendee to perform any services that he or she is not legally authorized to perform based on his or her permit type.

NetCE is approved as a provider of continuing education by the Florida Board of Dentistry, Provider #50-2405.

Designations of Credit

NetCE designates this activity for 5 continuing education credits.

AGD Subject Code 148.

This course meets the Dental Board of California's requirements for 5 units of continuing education.

Dental Board of California course #05-3841-00451.

A complete Works Cited list begins on page 25.

Mention of commercial products does not indicate endorsement.

About the Sponsor

The purpose of NetCE is to provide challenging curricula to assist healthcare professionals to raise their levels of expertise while fulfilling their continuing education requirements, thereby improving the quality of healthcare.

Our contributing faculty members have taken care to ensure that the information and recommendations are accurate and compatible with the standards generally accepted at the time of publication. The publisher disclaims any liability, loss or damage incurred as a consequence, directly or indirectly, of the use and application of any of the contents. Participants are cautioned about the potential risk of using limited knowledge when integrating new techniques into practice.

Disclosure Statement

It is the policy of NetCE not to accept commercial support. Furthermore, commercial interests are prohibited from distributing or providing access to this activity to learners.

Course Objective

The purpose of this course is to familiarize dental professionals with infection control techniques in order to minimize the risks of microbial transmission in the dental healthcare setting.

Learning Objectives

Upon completion of this course, you should be able to:

1. Outline OSHA regulations that impact the provision of dental care.
2. Analyze potential modes of transmission and pathogens that can result in infection in dental facilities.
3. Discuss potential prevention strategies for infection control, including Standard Precautions for hand hygiene personal protective equipment, and respiratory hygiene.
4. Describe effective cleaning, sterilization, and disinfection measures that should be applied in dental care.
5. Identify steps that should be taken to protect dental healthcare personnel, including vaccination, education, and exposure responses.

INTRODUCTION

In 2023, there were more than 751,000 jobs in dental occupations in the United States [1]. Most of these dental workers come in daily contact with a variety of infectious diseases in their workplace and are at risk for both transmitting and contracting these diseases.

Universal Precautions were originally developed and recommended by the Centers for Disease Control and Prevention (CDC) in the 1980s as an infection control approach to protect healthcare professionals from bloodborne pathogens. Under Universal Precaution recommendations, all human blood and certain bodily fluids are treated as if they are infectious, regardless of patient or setting. In 1996, the CDC expanded these recommendations and introduced Standard Precautions, not only to protect healthcare workers from pathogens in human blood and body fluids but also from pathogens present in bodily fluids that are not covered under Universal Precautions, including saliva during dental procedures. Standard Precautions are the minimum standard of care applied to all patients, and include hand hygiene, use of specific types of personal protective equipment (PPE) based on anticipated exposure, safe injection practices, and management of contaminated environmental items. In addition to Standard Precautions, Transmission-Based Precautions (i.e., Contact Precautions, Droplet Precautions, and Airborne Precautions) are used to prevent transmission of an infectious agent that is not interrupted by Standard Precautions alone. The type of Transmission-Based Precaution used is based on what is known or suspected about a patient's infection. A written protocol should be developed for proper instrument processing, operatory cleanliness, and management of injuries, and a copy of infection control regulations should be conspicuously posted in each dental office [2].

INFECTION CONTROL REGULATIONS

Legal issues first began to impact infection control practices at the beginning of the acquired immunodeficiency syndrome (AIDS) epidemic in the early 1980s. The need to protect healthcare workers from bloodborne exposures resulted in the publication of the Bloodborne Pathogens Standard by OSHA in 1991 [3].

BLOODBORNE PATHOGENS STANDARD

The OSHA Standard requires employers whose employees have exposure to blood or other potentially infectious material (OPIM) to implement safe work practices, education, and barriers to exposure. OPIM includes saliva in dental procedures and all bodily fluid in situations where it is difficult or impossible to differentiate between bodily fluids; any unfixed tissue or organ (other than intact skin) from a human (living or dead); human immunodeficiency virus (HIV)-containing cell or tissue cultures, organ culture and blood, or other tissues from experimental animals [9]

The OSHA Bloodborne Pathogens Standard requires that every healthcare worker who may have contact on the job with blood or other bodily fluids must receive specific annual education, which includes instruction in the basics of infection control and prevention. Training must also cover bloodborne pathogens, modes of transmission, the proper use of needles, and Transmission-Based Precautions [2; 3].

COMMON MODES OF INFECTION TRANSMISSION	
Category	**Definition**
Direct contact	Person-to-person transmission of pathogens (e.g., through skin, blood, or body fluid contact)
Indirect contact	An intermediate person or item acts as a transport between the portal of exit in one person and the portal of entry to the next person (e.g., via unwashed hands, shared equipment, needlesticks)
Droplets[a]	Large respiratory droplets propelled by an infected person coughing, sneezing, talking, or breathing heavily. Droplets settle rapidly within 6 feet of the individual on surfaces and in the upper airway of individuals exposed via the eyes, nose, or mouth.
Airborne (aerosols)[a]	Small particles or micro-droplets are released into the air by an infected person coughing, sneezing, talking, or breathing heavily. Airborne pathogens can linger for long periods of time and travel longer distances, landing on surfaces and being breathed in by other individuals into the lower airway.
Fomites	Contact with a contaminated inanimate object (e.g., used gloves, pens, used tissues, soiled laundry, keyboards, furniture).
Water	Water may be contaminated by micro-organisms in dental water unit lines, causing patient contamination as well as dispersing infected airborne particles and droplets.
[a]In 2024, a global consensus was reached to replace the terms droplet, airborne, and aerosol with a general umbrella term of "through the air transmission," regardless of infected respiratory particle size and/or distance traveled.	
Source: [5; 6; 8]	*Table 1*

AEROSOL TRANSMISSIBLE DISEASE STANDARD

In 2009, the California Division of Occupational Safety and Health (Cal/OSHA) adopted the nation's first aerosol transmissible disease (ATD) standard, which remains in effect today [4]. The standard is designed to protect healthcare workers from diseases spread by an airborne or droplet route. The ATD standard requires employers in health care to develop exposure control procedures and train employees to follow those procedures [4]. Basic exposure precautions, such as source screening, infection control, hand hygiene, and cleaning and decontamination procedures, are a fundamental part of the standard. Employees must be included in the periodic review and assessment of these procedures.

As of 2024, California remains the only state with such a permanent standard; however, the coronavirus disease (COVID) pandemic of 2019–2022 highlighted the need for a standard addressing infectious pathogens spread by aerosols or droplets. During the pandemic, OSHA did issue interim guidance for safe workplaces, and some states issued emergency temporary standards. Experts have called for these requirements to be codified in order to ensure the safety of professions and patients, but this has not yet been accomplished [15]. Although not required in other states, thorough guidance on aerosol-transmissible diseases can be found in the 2023 California Workplace Guide to Aerosol Transmissible Diseases at https://www.dir.ca.gov/dosh/dosh_publications/ATD-Guide.pdf [4].

MODES OF TRANSMISSION

Almost all pathogens are transmitted by being carried from one place to another. The mode or means of transmission is the weakest link in the chain of infection, and it is the only link that can be eliminated entirely. Most infection control efforts are aimed at preventing transmission of pathogens from a reservoir to a susceptible host. Both Standard and Transmission-Based Precautions are designed to interrupt the mode of transmission. ***Table 1*** details the most common modes of infection transmission in dentistry [5; 6; 8]

DIRECT AND INDIRECT CONTACT

The most common modes of transmission in the healthcare setting are through contact, both direct and indirect. Because it addresses the weakest link in the chain of transmission, hand hygiene is the single most important procedure for preventing the spread of infection. Items moving between patients should be cleaned and sterilized after each use to avoid indirect transmission of pathogens. Standard Precautions in conjunction with identified Contact Precautions are often used in the dental setting.

Bloodborne Pathogens

Healthcare employees can be exposed to blood through needlestick and other sharps injuries, damaged mucous membranes, and broken skin exposures. The pathogens of primary concern to dental professions are HIV, hepatitis B virus, and hepatitis C virus.

Hepatitis B Virus

Healthcare personnel who have received the hepatitis B vaccine and developed immunity to the virus are at virtually no risk for infection. For a susceptible person, the risk from a single needlestick or cut exposure to hepatitis B-infected blood ranges from 6% to 30%, depending on the hepatitis B antigen status of the source individual. While there is a risk for hepatitis B infection from exposures of mucous membranes or nonintact skin, there is no known risk for infection from exposure to intact skin [5; 10].

Hepatitis C Virus

Hepatitis C is transmitted primarily through percutaneous exposure to infected blood. The average risk for infection after a needlestick or cut exposure to hepatitis C virus-infected blood is approximately 1.8%. The risk following a blood exposure to the eye, nose, or mouth is unknown but is believed to be very small; however, hepatitis C virus infection from blood splashes to the eye has been reported. There also has been a report of hepatitis C virus transmission that may have resulted from exposure to nonintact skin, but there is no known risk from exposure to intact skin. Documented transmission of hepatitis C or hepatitis B virus has resulted from using the same syringe or vial to administer medication to more than one patient, even if the needle was changed [5; 10].

The prevalence of hepatitis C virus infection among dentists and surgeons is similar to that among the general population, approximately 1% to 2% [5]. No studies of transmission from hepatitis C virus-infected dental healthcare personnel to patients have been reported, and the risk for such transmission appears limited [10].

HIV/AIDS

The average risk of HIV infection after a needlestick or cut exposure to HIV-infected blood is 0.3%; 99.7% of needlestick or cut exposures do not lead to infection. The risk after exposure of the eye, nose, or mouth to HIV-infected blood is estimated to be 0.1%. There have been no documented cases of HIV transmission due to an exposure involving a small amount of blood on intact skin (i.e., a few drops of blood on skin for a short period of time) [5; 10].

In the United States, the risk of HIV transmission in dental settings is extremely low. According to surveillance data from 1981 to 2013, a total of 58 cases of HIV seroconversion had been documented among healthcare personnel after occupational exposure to a known HIV-infected source, but none were among dental care personnel [12].

Certain factors affect the risk of HIV transmission after an occupational exposure. Laboratory studies have determined if needles that pass through latex gloves are solid rather than hollow-bore or are of small gauge (e.g., anesthetic needles), less blood is transferred. In a retrospective, case-control study of healthcare personnel, an increased risk for HIV infection was associated with exposure to a relatively large volume of blood, as with a deep injury with a device that was visibly contaminated with the patient's blood or a procedure that involved a needle placed in a vein or artery [12]. The risk was also increased if the exposure was to blood from patients with terminal illnesses, possibly reflecting the higher titer of HIV in patients with late-stage AIDS.

AEROSOLS, DROPLETS, AND SPLATTER

Aerosols, droplets (produced by the respiratory tract), and splatter contaminated with blood and bacteria are produced during many dental procedures. Devices such as dental handpieces, ultrasonic and sonic scalers, air polishers, air-water syringes, and air abrasion units produce visible aerosol clouds and possible airborne contamination. Splatter generated by dental procedures such as drilling is a primary risk for transmission of bloodborne pathogens. In general, because of their smaller size, aerosols pose the greatest risk for airborne infection [9].

Several studies have shown that airborne or droplet nuclei may extend up to 6 feet away from the source and can remain airborne for up to 30 minutes after a procedure. Tuberculosis (TB) is of special concern because it is a large particle that can remain airborne or can dry on a surface and become airborne again as part of a dust particle.

In 2024, the World Health Organization (WHO) and the Centers for Disease Control and Prevention from the United States, China, Europe, and Africa, published a global consensus of the terminology for pathogens that transmit through the air. Key changes include [8]:

- Any infected particles that are expelled from an individual through nose or mouth are referred to as "infectious respiratory particles" (IRPs).
- IRPs exist on a spectrum of sizes and should no longer be distinguished as "small" (aerosol) or "large" (droplet).
- The descriptor "through the air transmission" should be used to characterize any transmission that involves a pathogen moving through the air or being suspended in the air. Two further descriptors can be used:
  - Airborne transmission or inhalation: IRPs are expelled into the air and inhaled by another person. This can occur at short or long distances, dependent on various factors (e.g., airflow, humidity, temperature, ventilation).
  - Direct deposition: IRPs are expelled into the air and directly deposited on the exposed mouth, nose, or eyes of another person.

Due to the existing research and recommendations primarily using the terms and definitions of "aerosol" and "droplet," these terms will continue to be used throughout this course, unless otherwise noted.

The American Dental Association recommends that in addition to using Universal and Standard Precautions, such as masks, gloves, and eye protection, Transmission-Based Precautions, including the proper sterilization of instruments and treatment of dental unit waterlines is necessary to reduce or eliminate this source of potentially contaminated dental aerosols. Preprocedural rinsing with an antimicrobial mouthwash such as chlorhexidine is also recommended, although it is only effective for oral bacteria found in saliva and those adhering to mucous membranes. It does not penetrate subgingivally and likely has no effect on bacteria in the nasopharynx [5; 6].

Diseases known to spread by aerosols or droplet include:

- TB
- Pneumonic *Yersinia pestis* infection (plague)
- Influenza
- Legionellosis (Legionnaires disease)
- Measles
- Chickenpox
- Disseminated shingles
- Severe acute respiratory syndrome and coronavirus (SARS and COVID)

Procedures or equipment aimed at eliminating the means of transmission include [5; 6]:

- Universal preprocedural rinses
- Dental dams for certain procedures
- High-volume evacuator (HVE) at the treatment site (An HVE can only remove airborne contamination if it removes a large volume of air. A saliva ejector does not remove enough air to be classified as an HVE.)
- High-efficiency particulate arresting and ultraviolet filters in the ventilation system
- Disposable PPE discarded after each patient (e.g., gloves, masks, gowns)
- Cleaning, disinfection, and sterilization of equipment used by more than one patient
- Environmental cleaning and disinfection, especially of high-touch surfaces

FOMITE TRANSMISSION

Devices can transmit pathogens if they are contaminated with blood or bodily fluids or are shared without cleaning, disinfecting, and sterilizing between patients; these are classified as fomites. Surgical instruments that are inadequately cleaned between patients or that have manufacturing defects that interfere with the effectiveness of reprocessing may transmit bacterial, fungal, and viral pathogens. Clothing, uniforms, laboratory coats, or gowns used as PPE may become contaminated with potential pathogens after care of a patient colonized or infected with an infectious agent [5; 6; 10].

WATER TRANSMISSION

Dental water units and dental unit waterlines are both potential sources of transmission and potential reservoirs. Routine cleaning and sterilization and adherence to the CDC's recommended procedures for treating dental unit waterlines have been shown to be effective in eliminating transmission of infectious organisms via these devices. Infections known to be caused by dental-related water transmission include *Pseudomonas aeruginosa*, *Mycobacterium avium*, and *Legionella pneumophila* [5; 7].

STANDARD PRECAUTIONS

Since the 1980s, regulatory and legislative activity has focused on implementing a hierarchy of prevention and control measures to improve infection control in healthcare settings. The gradual acceptance of various infection prevention standards has changed the way we work in the provision of dental care. The use of Standard Precautions reduces the risk of infection to staff and patients and ensures that the right precautions are used with both known and unknown carriers of diseases due to bloodborne pathogens. Standard Precautions apply to contact with blood, intact or nonintact skin, mucous membranes, and all bodily fluids, secretions, and excretions (except sweat), regardless of whether they contain blood. A central tenet of Standard Precautions is to consider all patients to be potentially infected with a bloodborne pathogen. Saliva has always been considered a potentially infectious material in dental infection control; thus, no operational difference exists in clinical dental practice between Universal Precautions and Standard Precautions. For organisms other than bloodborne pathogens, early identification and prompt isolation are critical.

As noted, Standard Precautions are the minimum infection prevention practices that apply to all patient care, regardless of health or dental care setting, and include [5]:

- Utilization of effective hand hygiene
- Use of PPE (e.g., gloves, masks, eyewear)
- Respiratory hygiene, including cough/sneeze etiquette
- Sharps safety (engineering and work practice controls)
- Safe injection practices (aseptic technique)
- Cleaning, sterilization, and disinfection of instruments and devices
- Cleaning and disinfection of environmental surfaces

HAND HYGIENE

Despite the simplicity and effectiveness of hand hygiene in preventing the spread of infectious disease, adherence to hand hygiene practice remains low. Adherence varies among professional categories of healthcare workers but is usually estimated at less than 50%. Healthcare providers may be required to clean their hands as many as 100 times in a 12-hour shift, depending on the number of patients and intensity of care [14; 17]. For dental healthcare workers, strict adherence to proper hand hygiene is the most important prevention strategy to protect both the patient and the worker. In one study, adherence rates to hand hygiene among postgraduate-year dentists found that overall handwashing compliance rate was 34.7%, with higher rates of compliance noted in oral surgery services (92.8%) than during work in general clinical practice (34.2%) [13]. The World Health Organization has designed the guidelines 5 Moments for Hand Hygiene as a reminder of when proper hand hygiene should be completed [11]:

1. Before touching a patient
2. Before a procedure
3. After a procedure or exposure to body fluids
4. After touching a patient
5. After touching a patient's surroundings

In general, perform hand hygiene [14]:

- After contact with any bodily fluids, including your own
- Before any non-invasive or invasive procedure
- Each time you remove your gloves
- When your hands feel or look dirty
- After contact with contaminated things or environments, such as charts
- After handling used equipment or linen
- After using the bathroom
- Before contact with any portal of entry, your patient's or your own
- Before and after eating

A number of conditions restrict dental healthcare professionals from participating in direct patient care. These include weeping dermatitis, exudative lesions, or any hand condition that increases the risk of disease transmission [9].

Good handwashing is difficult to practice, is rarely known or taught, and is one of the single most effective ways to prevent transmission of many diseases, including influenza. Everyone knows to wash their hands before eating and after using the restroom. However, few do little more than remove obvious dirt. Good handwashing involves removing the skin oils where organisms can remain even when the hands look clean. A quick pass under the water faucet and fast dry with a towel may remove visible dirt, but the oils and organisms remain.

To effectively remove the oils and organisms, the process should take at least 20 seconds, or the amount of time it takes to sing "Twinkle, Twinkle Little Star." The hands should be soaped and rubbed vigorously for 15 seconds to create a good lather and to assure that all parts of each hand are soaped and rubbed well. Then, the hands should be rinsed thoroughly and dried, preferably with a paper towel. The towel should be used to turn off the water faucet and then properly thrown away. However, 20 seconds is a long time in the busy life of a healthcare provider, and this 20 seconds has been identified as a major barrier to handwashing, particularly among those who consider themselves "too busy" to wash their hands. If there is no visible dirt or contamination, a waterless hand sanitizer with at least 60% alcohol can be used between patients. However, nothing is as good as washing well with soap and water. Further, some organisms are not eliminated through the use of hand sanitizers alone (e.g., *Clostridioides difficile* spores). Hands should be thoroughly dried before donning gloves and washed again immediately after glove removal [9].

Some mistakenly think that hot water must be used to kill the organisms. Water hot enough to kill organisms would be too hot to touch. Warm water softens oils but mainly adds to comfort and encourages better washing technique (i.e., longer duration). Careful attention to handwashing and cleansing may result in chapped skin, so the dental professional must find effective lotions to care for his/her hands [14; 17].

Certain soaps contain stronger antiseptic compounds, such as chlorhexidine, and these soaps may be considered in cases in which exposure to potentially infectious material is likely. Antiseptic soaps or surgical preparation liquids have been found more effective than plain soap in removing bacteria from healthcare workers hands both pre- and postprocedure. In addition, antiseptics may be added to alcohol-based handrubs in order to achieve persistent germicidal activity. Possible side effects associated with frequent use of antiseptic hand scrubs include skin irritation, dermatitis, allergic reactions, and potential development of microbial resistances. Chlorhexidine products are considered safe for regular use in dental practice; however, if associated side effects are bothersome, they may result in decreased hand hygiene compliance [10; 14].

In summary, start and end each work day using an antibacterial soap. Gloves provide a breeding ground for microbial growth, and washing before and after use is encouraged. If hands are not visibly soiled, a waterless hand sanitizer (at least 60% alcohol) may be used. For surgical procedures, wash hands with antimicrobial soap prior to gowning and gloving [5].

PERSONAL PROTECTIVE EQUIPMENT

PPE is defined as special coverings designed to protect healthcare personnel from exposure to or contact with infectious agents [18]. Under OSHA's General Duty Clause, PPE is also required for any potential infectious disease exposure. Employers must provide their employees with appropriate PPE and ensure its proper disposal. If reusable, it must be properly cleaned or laundered, repaired, and stored after use [19]. PPE must fit the individual user, and it is up to the employer to ensure that PPE is available in sizes appropriate for all their workers. Employees are prohibited from taking PPE home to launder.

In addition to the familiar gloves, masks, and gowns, PPE includes a variety of barriers and respirators used alone or in combination to protect skin, mucous membranes, and airways from contact with infectious agents. The selection of PPE is based on the nature of the patient/provider interaction and the likely mode of transmission. Primary PPE used in oral healthcare settings includes gloves, surgical masks, respiratory devices, protective eyewear, face shields, and protective shoes and clothing.

Procedures that can generate splashes or sprays of blood, bodily fluids, secretions, excretions, or chemical agents require either a face shield (disposable or reusable) or mask and goggles. The wearing of masks, eye protection, and face shields in specified circumstances (when blood or OPIM exposures are likely to occur) is mandated by the OSHA Bloodborne Pathogens Standard. Sterile barriers for invasive procedures and masks or respirators for the prevention of droplet contamination are also required [2].

The use of PPE is not a substitute for safe work practices. Avoid contaminating yourself by keeping your hands away from your face and not touching or adjusting equipment. PPE is a potential means of transmission if not changed between patients. All PPE should be removed when leaving patient care areas.

Gloves

Dental personnel should wear medical exam gloves to prevent contamination of their hands when touching mucous membranes, blood, saliva, or OPIM [9]. Gloves reduce the likelihood that micro-organisms present on the hands will be transmitted to patients during surgical or other patient-care procedures. Gloves used in the healthcare setting are subject to U.S. Food and Drug Administration (FDA) evaluation and clearance. Nonsterile, disposable medical gloves made of latex or nitrile should be available for routine patient care. Dental personnel should always use gloves when [18]:

- Anticipating direct contact with blood or bodily fluids, mucous membranes, nonintact skin, and OPIM
- Engaging in direct contact with patients who are colonized or infected with pathogens transmitted by the contact route, such as vancomycin-resistant enterococci or methicillin-resistant *Staphylococcus aureus* (MRSA)
- Handling or touching visibly or potentially contaminated patient care equipment and environmental surfaces

Studies have repeatedly shown that vinyl gloves have higher failure rates than latex or nitrile gloves. For this reason, either latex or nitrile gloves are preferable for clinical procedures that require manual dexterity or those involving more than brief patient contact. Heavier, reusable utility gloves should be used for non-patient-care activities, such as handling or cleaning contaminated equipment or surfaces, handling chemicals, or disinfecting contaminated tools [9; 18].

During dental procedures, patient examination gloves commonly contact multiple types of chemicals and materials, such as disinfectants and antiseptics, composite resins, and bonding agents, and these materials can compromise the integrity of latex, nitrile, and other synthetic glove materials. In addition, latex gloves can interfere with the setting of vinyl polysiloxane impression materials. Given the diverse selection of dental materials on the market, dental practitioners should consult glove manufacturers regarding the chemical compatibility of glove materials [5; 18].

Wearing sterile surgeon's gloves during surgical procedures has a strong theoretical rationale. Sterile gloves minimize transmission of micro-organisms from the hands of surgical personnel to patients and prevent contamination of the hands of surgical personnel with the patient's blood and bodily fluids. In addition, sterile surgeon's gloves are more rigorously regulated by the FDA and may provide an increased level of protection for the provider if exposure to blood is likely [10; 18].

Gloves should be removed and replaced if torn or punctured and discarded between patients to prevent transmission of infectious material. They should never be washed and reused, as micro-organisms cannot be removed reliably from glove surfaces. Glove reuse has been associated with transmission of MRSA and gram-negative bacilli [9; 10].

When gloves are worn in combination with other PPE, they should be put on last. Gloves that fit snugly around the wrist are preferred for use with a gown because they will cover the gown cuff and provide a more reliable continuous barrier for the arms, wrists, and hands. Removing gloves properly also prevents hand contamination. Hand hygiene following glove removal ensures that the hands will not carry potentially infectious material that might have penetrated through unrecognized tears or contaminated the hands during glove removal.

When processing contaminated sharp instruments, needles, and devices, heavy utility gloves should be used to prevent puncture injuries [10; 18].

When adhering to Standard Precautions, always [5]:

- Use good hand hygiene.
- Use gloves for contact with blood, bodily fluids, nonintact skin (including rashes), mucous membranes, used equipment, linens, and trash.
- Change gloves if they become heavily soiled when working on a patient or if you must go from a potentially more infective area to a lesser one.

In addition, never:

- Wear artificial fingernails.
- Touch a second patient with the same pair of gloves used on the first patient.
- Contaminate the environment with dirty gloves.
- Wear gloves outside the treatment area unless you can say why you are wearing them.

Protective Clothing

Gowns are intended to protect the arms and exposed body areas and prevent contamination of clothing with blood, bodily fluids, and OPIM. The type of gown selected is based on the nature of the patient/provider interaction, including the anticipated degree of contact with infectious material and potential for blood and bodily fluid penetration of the barrier. General work clothes (e.g., uniforms, scrubs, laboratory coats, jackets) are not considered PPE. Dental personnel should change protective clothing when it becomes visibly soiled or as soon as possible if penetrated by blood or other possibly infectious fluid [18].

Masks, Protective Eyewear, and Face Shields

In general, dental professionals are required to wear surgical masks that cover both the nose and mouth, in combination with either chin-length plastic face shields or protective eyewear when there is potential for splashing or spattering of blood, droplets, chemical, or germicidal agents, or OPIM. After each patient, masks should be changed and disposed of properly. After each patient treatment, face shields and protective eyewear shall be cleaned and disinfected, or disposed [9; 18].

Masks should fit snugly and fully cover the nose and mouth to prevent fluid penetration. For this reason, masks that have a flexible nose piece and can be secured to the head with string ties or elastic are preferable. Surgical masks protect against microorganisms generated by the wearer and also protect dental personnel from large-particle droplet spatter that might contain bloodborne pathogens or OPIM. If the mask becomes wet or contaminated, it should be changed between patients or even during patient treatment. For employees at increased risk of exposure to ATDs, such as those working in endemic areas (e.g., Southeast Asia) or in areas designated for isolation or quarantine, the employer must provide a respirator at least as effective as an N95 respirator.

Most surgical masks are not National Institute for Occupational Safety and Health (NIOSH)-certified as respirators, do not protect the user adequately from exposure to TB, and do not satisfy OSHA requirements for respiratory protection. However, certain surgical masks (i.e., N95 respirators) do meet the requirements and are certified by NIOSH. The level of protection a respirator provides is determined by the efficiency of the filter material for incoming air (e.g., 95% for N95) and how well the face piece fits or seals to the face. N95 respirators are required to be labeled as such on the device.

Respirators are used when treating patients with diseases requiring Airborne Precautions and should be used in the context of a complete respiratory protection program. This program should include training and fit testing to ensure an adequate seal between the edges of the respirator and the wearer's face.

Goggles with side shields provide barrier protection for the eyes and should fit snugly over and around the eyes or personal prescription lenses. Personal prescription lenses do not provide optimal eye protection and should not be used as a substitute for goggles. If goggles or face shields are reusable, they must be placed in a designated receptacle for subsequent reprocessing. If they are not reusable, they may be discarded in a designated waste receptacle.

Face shields extending from chin to crown provide better face and eye protection from splashes and sprays than goggles. Shields that wrap around the sides may reduce splashes around the edge. Removal of a face shield, goggles, and mask can be performed safely after gloves have been removed and hand hygiene performed. The ties, ear pieces, or headband used to secure the equipment to the head are considered clean and therefore safe to touch with bare hands. The front of the face shield is considered contaminated [10; 18].

RESPIRATORY HYGIENE

If dental clinics and offices comply with state regulations for screening of patients with ATDs, they are not required to comply with the new standards for prevention of transmission of ATDs [4]. However, because no screening process is universally effective, dental personnel should be aware of the potential dangers associated with transmission of pathogens via the airborne and droplet routes.

Respiratory droplets can transmit infection when they travel directly from the respiratory tract of the infected individual to the mucosal surfaces of the recipient, generally over short distances (i.e., 6 feet or less). Airborne transmission occurs with only a few organisms that can survive the drying of respiratory droplets. When the droplets evaporate, they leave behind droplet nuclei, which are so small they remain suspended in the air and can travel over longer distances. Respiratory droplets and droplet nuclei are generated when an infected person coughs, sneezes, or talks during procedures. Facial masks or shields generally provide direct protection from droplet transmission. Some pathogens transmitted via the airborne route (e.g., TB) require the use of an N95 respirator or better (e.g., N99, N100) due to the small particle size [5].

Measures to contain respiratory secretions in symptomatic patients and accompanying adults may include [5; 18]:

- Post signs to instruct patients with known or suspected respiratory infection to cover mouth and nose when sneezing or coughing, use and properly dispose of tissues, and wash hands after sneezing or coughing.
- Provide tissues and no-touch receptacles.
- Have handwashing stations or hand sanitizer available in waiting areas.
- Offer masks to patients and accompanying adults.
- Provide ample space in waiting areas, or consider placing symptomatic patients in a separate waiting area.

ENGINEERING AND WORK PRACTICE CONTROLS (SHARPS SAFETY)

Most percutaneous injuries among dental professionals involve scalers, burs, needles, wires, and sharp instruments. In 2000, the Federal Needlestick Safety and Prevention Act authorized OSHA to revise its Bloodborne Pathogens Standard to require the use of safety-engineered sharp devices in healthcare settings [2; 3; 16]. Guidelines on the design, implementation, and evaluation of a sharps injury prevention program have been developed by the CDC, and outline engineering controls and work practice controls as primary methods to prevent such occurrences. Engineering controls, such as sharps disposal containers, self-sheathing needles, and safer medical devices (e.g., sharps with engineered sharps injury protections and needleless systems) isolate or remove the bloodborne pathogens hazard from the workplace. On the other hand, work practice controls reduce the likelihood of exposure by specifying the manner in which a task is performed (e.g., prohibiting recapping of needles by a two-handed technique).

Engineering and work practice controls are intended to work synergistically to eliminate or minimize employee exposure. These controls must be examined and maintained or replaced on a regular basis to ensure their effectiveness. To maintain a safe workplace, employers must provide handwashing facilities that are readily accessible to employees.

Contaminated needles and other contaminated sharps should not be bent, recapped, or removed unless the employer can demonstrate that there is no alternative or that such action is required by a specific procedure. Necessary bending, recapping, or needle removal must be accomplished through the use of a mechanical device or a one-handed scoop technique. Shearing or breaking of contaminated needles is prohibited. Immediately, or as soon as possible after use, contaminated reusable sharps (e.g., scalpels, dental knives) must be placed in appropriate containers until properly reprocessed. These containers must be [9; 10]:

- Puncture resistant
- Labeled or color-coded
- Leak-proof on the sides and bottom
- Maintained in accordance with OSHA requirements for reusable sharps
- Designed so personnel are not required to reach by hand into the container
- Located as close as possible to the point of use

SAFE INJECTION PRACTICES (ASEPTIC TECHNIQUE)

Safe injection practices are designed to prevent disease transmission within the healthcare setting. The absence of visible blood or other signs of contamination in a used syringe does not mean the item is free from potentially infectious agents. Bacteria and other microbes can be present without any visible evidence of contamination. All used injection supplies and materials should be considered potentially contaminated and should be discarded.

To ensure safe injection practices, use aseptic technique throughout all aspects of injection preparation and administration. Aseptic technique involves the handling, preparation, and storage of medications in a manner that prevents microbial contamination. It also applies to the handling of all supplies used for injections and infusions. To avoid contamination, medications should be drawn in a clean medication preparation area. Any item that may have come in contact with blood or OPIM should be kept separate from medications. In addition, eating, drinking, smoking, applying cosmetics or lip balm, and handling contact lenses are prohibited in work areas where there is a reasonable likelihood of occupational exposure. Food and drink should not be kept in refrigerators, freezers, shelves, or cabinets or on countertops where blood or OPIM is present.

A new, sterile syringe and needle should be used to draw up medications while preventing contact between the injection materials and the nonsterile environment. Practice proper hand hygiene before handling medications, and discard medication vials upon expiration or any time there are concerns regarding the sterility of the medication [5].

Never leave a needle or other device inserted into a vial or bottle for multiple uses. This provides a direct route for micro-organisms to enter the vial and contaminate the fluid. Medications should never be combined between vials or administered from the same syringe to more than one patient, even if the needle is changed. Multidose vials should be used on a single patient whenever possible and should never enter the immediate patient treatment area [5].

Dental professionals should follow proper technique when using and handling needles, cannulae, and syringes. Whenever possible, use sharps with engineered sharps injury protections (e.g., non-needle or needle devices with built-in safety features or mechanisms that effectively reduce the risk of an exposure incident). Do not disable or circumvent the safety feature on devices [5].

Cases of bloodborne pathogen transmission as a result of improper injection practices have common themes. Often, aseptic technique and Standard Precautions were not carefully followed. Infection control programs may be lacking or responsibilities unclear. In several instances, failure to recognize an infection control breach has led to prolonged transmission and a growing number of infected patients. In all cases, investigations were time-consuming and costly and required the notification, testing, and counseling of hundreds and sometimes thousands of patients [5; 16].

STERILIZATION AND DISINFECTION OF PATIENT-CARE ITEMS AND DEVICES

Application of accepted infection control principles helps maintain a safe environment for both patients and dental care workers. This includes proper use of Standard Precautions and application of approved techniques for cleaning, disinfection, sterilization, and reprocessing of dental equipment. Healthcare policies must identify—primarily on the basis of an item's intended use—whether cleaning and disinfection or sterilization is indicated (***Table 2***) [9; 10; 21].

Cleaning is defined as the removal of visible soil (organic and inorganic material) debris and OPIM from objects and surfaces; normally, it is accomplished manually or mechanically using water with detergents or enzymatic products [9]. Cleaning must precede any disinfection or sterilization process.

Decontamination reduces the number of pathogenic micro-organisms on objects, usually with a 0.5% chlorine solution [21]. Thorough cleaning and decontamination are essential before high-level disinfection and sterilization because inorganic and organic materials that remain on the surfaces of instruments interfere with the effectiveness of these processes.

Disinfection is a process that eliminates many or all pathogenic micro-organisms, except bacterial spores, on inanimate objects. In healthcare settings, objects are usually disinfected using liquid chemicals or wet pasteurization (i.e., the use of hot water to destroy micro-organisms). There are three levels of disinfection [9; 10]:

- High-level disinfection: Used to disinfect patient-care equipment that touches mucous membranes or blood.
- Intermediate-level disinfection: Used mainly to disinfect items that have contact with intact skin, but is appropriate for certain semicritical items (e.g., chair arms).
- Low-level disinfection: Used to disinfect the healthcare environment or items that touch intact skin.

METHODS FOR STERILIZING AND DISINFECTING PATIENT-CARE ITEMS AND ENVIRONMENTAL SURFACES					
Process	**Result**	**Method**	**Examples**	**Patient Care Items**	**Environmental Surfaces**
Sterilization	Destroys all forms of viable micro-organisms, including bacterial spores.	Heat-automated, high temperature	Steam, dry heat, unsaturated chemical vapor	Heat-tolerant critical and semicritical	NA
		Heat-automated, low temperature	Ethylene oxide gas, plasma sterilization	Heat-sensitive critical and semicritical	
		Liquid immersion[a]	Glutaraldehyde, glutaraldehydes with phenols, hydrogen peroxide, hydrogen peroxide with peracetic acid, peracetic acid		
High-level disinfection	Destroys all micro-organisms, but not necessarily high numbers of bacterial spores.	Heat-automated	Washer disinfector	Heat-sensitive semicritical	NA
		Liquid immersion[a]	Glutaraldehyde, glutaraldehydes with phenols, hydrogen peroxide, hydrogen peroxide with peracetic acid, ortho-phthalaldehyde		
Intermediate-level disinfection	Destroys vegetative bacteria and most fungi and viruses. Inactivates *Mycobacterium bovis*[b]. Not necessarily capable of killing bacterial spores.	Liquid contact	EPA-registered 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 and certain fungi and viruses. Does not inactivate *Mycobacterium bovis*.	Liquid contact	EPA-registered hospital disinfectant with no label claim regarding tuberculocidal activity. OSHA also requires label claim of HIV and HBV potency for use of low-level disinfectant for use on clinical contact surfaces (e.g., quaternary ammonium compounds, some phenolics, some iodophors)	Noncritical without visible blood	Clinical contact surfaces, housekeeping surfaces

[a]Contact time is the single critical variable distinguishing the sterilization process from high-level disinfection with FDA-cleared liquid chemical sterilants. High-level disinfection uses shorter submersion times.
[b]Inactivation of the more resistant *Mycobacterium bovis* is used as a benchmark to measure germicidal potency.

Source: [9; 10; 21] *Table 2*

Surface disinfection is an important part of environmental cleaning. Most bacteria and mycobacteria (e.g., TB) survive for several months on dry surfaces [20]. Respiratory viruses, such as coxsackie or influenza, can persist on surfaces for a few days. Hepatitis viruses and HIV can persist for more than one week, and herpes viruses have been shown to persist from only a few hours up to seven days [20]. All surfaces in patient care areas should be cleaned then disinfected according to the manufacturer's instructions and allowed to dry completely.

Sterilization is a process that destroys or eliminates all forms of microbial life and is carried out in healthcare facilities by physical or chemical methods. Sterile and nonsterile are absolute concepts. If a sterile item is touched by anything nonsterile, the formerly sterile item is contaminated.

The sterilization area should be separate from any patient care or staff break areas. The sterilization section of the processing area should include the sterilizers and related supplies, with adequate space for loading, unloading, and cool down [10]. The area can also include incubators for analyzing spore tests and enclosed storage for sterile items and single-use items. Manufacturer and local building code specifications will determine placement and room ventilation requirements.

According to the CDC guideline, heat-tolerant dental instruments usually are sterilized by steam under pressure (autoclaving), dry heat, or unsaturated chemical vapor [10]. All sterilization should be performed by using medical sterilization equipment cleared by the FDA. The sterilization times, temperatures, and other operating parameters recommended by the manufacturer of the equipment used, as well as instructions for correct use of containers, wraps, and chemical or biological indicators, should always be followed [10]. Sterilization most often fails due to overloading.

Devices being sterilized should first be cleaned, as debris interferes with the sterilization process. If an ultrasonic unit is utilized, it should be covered while actively in use. Instruments should be fully dry prior to packaging and storage.

Storage practices for wrapped sterilized instruments can be either date- or event-related. Packages containing sterile supplies should be inspected before use to verify barrier integrity and dryness. Although some facilities continue to date every sterilized package and use shelf-life practices, other facilities have switched to event-related practices [10]. This approach recognizes that the product should remain sterile indefinitely, unless an event causes it to become contaminated (e.g., torn or wet packaging). Even for event-related packaging, the date of sterilization should be placed on the package, and if multiple sterilizers are used in the facility, the sterilizer used should be indicated on the outside of the packaging material to facilitate the retrieval of processed items in the event of a sterilization failure [10]. If packaging is compromised, the instruments should be re-cleaned, sterilized again, and packaged in new wrap.

Categorizing Patient-Care Items

Patient-care items (e.g., dental instruments, devices, and equipment) are categorized using the Spaulding classification system as critical, semicritical, or noncritical, depending on the potential risk for infection associated with their intended use.

Critical items are those items that enter sterile spaces, such as soft tissue or bone, or items that come into contact with the bloodstream. These items pose the greatest risk of transmitting infection and require sterilization. Examples of critical dental instruments include surgical instruments, periodontal scalers, scalpel blades, and surgical dental burs [9; 10]. Critical instruments, items, and devices should be discarded or pre-cleaned, packaged or wrapped, and sterilized after each use. Methods of sterilization include steam under pressure (autoclaving), chemical vapor, and dry heat. If a critical item is heat-sensitive, it should, at minimum, be processed with high-level disinfection and packaged or wrapped after disinfection. These instruments, items, and devices shall remain sealed and stored in a manner so as to prevent contamination, and shall be labeled with the date of sterilization and the specific sterilizer used if more than one sterilizer is utilized in the facility [9; 10].

Semicritical items touch intact mucous membranes or nonintact skin and have a lower risk of transmission. Examples of semicritical dental instruments include mouth mirrors, amalgam condensers, reusable dental impression trays, and dental handpieces. Because the majority of semicritical items in dentistry are heat-tolerant, they should be sterilized using heat. If a semicritical item is heat-sensitive, it should, at a minimum, be processed with high-level disinfection, which kills all microbial life except spores [9; 10; 21]. Semi-critical instruments, items, and devices should be pre-cleaned, packaged or wrapped, and sterilized after each use. Methods of sterilization include autoclaving, chemical vapor, and dry heat. If a semi-critical item is heat sensitive, it should, at minimum, be processed with high-level disinfection and packaged or wrapped upon completion of the disinfection process. These packages or containers shall remain sealed, shall be stored in a manner so as to prevent contamination, and shall be labeled with the date of sterilization and the specific sterilizer used if more than one sterilizer is utilized in the facility [9; 10].

Noncritical items pose the least risk of transmission of infection and include devices, equipment, and surfaces that come in contact with soil, debris, saliva, blood, OPIM, and intact skin, but not mucous membranes [9; 10]. Noncritical items include radiograph heads/cones, blood pressure cuffs, facebows, and pulse oximeters. In the majority of cases, cleaning and disinfection with an EPA-registered hospital low-level disinfectant labeled effective against HBV and HIV is adequate. When the item is visibly contaminated with blood or OPIM, an EPA-registered hospital intermediate-level disinfectant with a tuberculocidal claim (i.e., intermediate-level disinfectant) should be used [9; 10].

High-speed dental hand pieces, low-speed hand pieces, rotary components and dental unit attachments (e.g., reusable air or water syringe tips and ultrasonic scaler tips) shall be packaged and heat-sterilized in a manner consistent with the same sterilization practices as a semi-critical instrument or item [9]. Single-use disposable items such as prophylaxis angles, cups, brushes, tips for high-speed evacuators, saliva ejectors, air and water syringe tips, and gloves must be used for one patient only and discarded. Proper functioning of the sterilization cycle of all sterilization devices should be verified at least weekly through the use of a biologic indicator (such as a spore testing monitor). It is recommended that test results be documented and maintained for 12 months [9; 10]. Studies have demonstrated variability among dental practices in meeting sterilization standards. In one study, 49% of respondents did not challenge autoclaves with biological indicators. Other studies using biologic indicators found a high proportion (15% to 65%) of positive spore tests after assessing the efficacy of sterilizers used in dental offices [21].

Laboratory Areas

Splash shields and equipment guards should be used on dental laboratory lathes. Fresh pumice and a sterilized or new ragwheel should be used for each patient. Devices used to polish, trim, or adjust contaminated intraoral devices must be disinfected or sterilized and stored in a manner so as to prevent contamination [9].

All intraoral items, such as impressions, bite registrations, and prosthetic or orthodontic appliances, must be cleaned and disinfected with an intermediate-level disinfectant before manipulation in the laboratory and before placement in the patient's mouth. Such items should be thoroughly rinsed prior to placement in the patient's mouth [9].

Reprocessing Reusable Medical Equipment

Reusable instruments, medical devices, and equipment should be managed and reprocessed according to recommended and appropriate methods. Industry guidelines as well as equipment and chemical manufacturer recommendations should be used to develop and update reprocessing policies and procedures. Written instructions should be available for each instrument, medical device, and equipment reprocessed. The FDA has issued guidance on ensuring the safety of reusable medical devices [23].

All procedures involving blood or OPIM must be performed in such a manner as to minimize splashing, spraying, spattering, and generation of droplets of these substances. Splatter shields should be used on medical equipment associated with risk-prone procedures.

Equipment that may become contaminated with blood or OPIM must be examined before servicing or shipping and should be decontaminated as necessary, unless the employer can demonstrate that decontamination of such equipment or portions of such equipment is not feasible. A readily observable label should be attached to the equipment stating which portions remain contaminated. The employer must ensure that this information is conveyed to all affected employees, the servicing representative, and the manufacturer before handling, servicing, or shipping, so appropriate precautions may be taken.

Single-Use Devices

A single-use device is a device that is intended for use on a single patient during a single procedure. An unused single-use device is referred to as an original device. A reprocessed single-use device is an original device that has previously been used on a patient and has been subjected to additional processing and manufacturing for the purpose of an additional single use on a patient [22].

Dental Unit Waterlines, Biofilm, and Water Quality

Studies have shown that dental unit waterlines, such as narrow-bore plastic tubing that carries water to high-speed handpieces, air/water syringes, and ultrasonic scalers, can become colonized with micro-organisms, including bacteria, fungi, and protozoa. Protected by a polysaccharide layer known as a glycocalyx, these micro-organisms colonize and replicate on the interior surfaces of the tubing and form a biofilm. This biofilm serves as a reservoir that can increase the number of micro-organisms in the water used during dental treatment [10].

Manufactured dental units are now engineered to be anti-retractive to prevent patient material, such as oral micro-organisms, blood, and saliva, from entering a dental water system during treatment. These dental unit lines and devices should be purged with air or flushed with water at the beginning of the clinic day for at least two minutes prior to attaching handpieces, scalers, air water syringe tips, or other devices [9; 10]. The dental unit lines and devices should be flushed between each patient for a minimum of 20 seconds [9].

Commercial devices and procedures shown to improve the quality of water used in dental treatment include self-contained water systems with chemical treatment, in-line microfilters, and combinations of these treatments. Simply using tap, distilled, or sterile water will not eliminate bacterial contamination in treatment water if biofilms in the system are not controlled. Microbial load should be less than or equal to 500 colony-forming units of heterotrophic bacteria per milliliter (≤500 CFU/mL) of water, the standard set for drinking water by the EPA [7]. Removal or inactivation of dental waterline biofilms requires use of chemical germicides. The definition of "germicide" is a chemical agent that can be used to disinfect items and surfaces based on the level of contamination. All germicides must be used in accordance with intended use and label instructions [9].

Regarding irrigation, if a surgical procedure involves soft tissue or bone, the use of sterile coolants or irrigants should be used, delivered using a sterile delivery system [9; 10]. An example of the importance of water quality maintenance is the 2016 outbreak of mycobacterial infection from a Southern California dental clinic that led to the hospitalization of more than 60 children, the cause of which was determined to be bacteria introduced through water during pulpotomies [29]. In response, in 2019, California introduced an infection control standard that requires that water or other methods for irrigation must be sterile or contain recognized disinfect-

ing or antibacterial properties when performing procedures on exposed dental pulp; chlorhexidine, BioPure MTAD, and sodium hypochlorite are considered appropriate oral irrigants in this standard [29]. Dental professionals should refer to their state, local, and employer policies regarding dental unit waterlines and irrigation standards.

CLEANING AND DISINFECTION OF ENVIRONMENTAL SURFACES

As discussed, contaminated surfaces and objects can serve as the means of transmission for potential pathogens. The transfer of a micro-organism from an environmental surface to a patient is largely via hand contact with the surface. Although hand hygiene is important to minimize the impact of this transfer, cleaning and disinfecting environmental surfaces is fundamental in reducing their potential contribution to the incidence of infections [10].

All work areas, including contact surfaces and barriers, must be maintained in a clean and sanitary condition. Employers are required to determine and implement a written schedule for cleaning and disinfection based on the location, type of surface to be cleaned, type of soil present, and tasks or procedures being performed. All equipment and environmental and working surfaces must be properly cleaned and disinfected after contact with blood or OPIM.

If non-critical items or surfaces likely to be contaminated are manufactured in a manner preventing cleaning and disinfection, they should be protected with disposable impervious barriers. Disposable barriers should be changed when visibly soiled or damaged and between patients. Products used to clean items or surfaces prior to disinfection procedures should be clearly labeled and follow all material safety data sheet (MSDS) handling and storage instructions. Clean and disinfect all clinical contact surfaces that are not protected by impervious barriers using an EPA-registered, hospital grade low- to intermediate-level disinfectant after each patient. The low-level disinfectants used must be labeled effective against hepatitis B virus and HIV. Use disinfectants in accordance with the manufacturer's instructions. Clean all housekeeping surfaces (e.g., floors, walls, sinks) with a detergent and water or an EPA-registered, hospital-grade disinfectant. Chemical-resistant utility gloves should be worn when handling hazardous chemicals [9; 10].

Medical Waste Management

Federal, state, and local guidelines and regulations specify the categories of medical waste subject to regulation and outline the requirements associated with treatment and disposal. Regulated medical waste is defined as [10]:

- Liquid or semi-liquid blood or OPIM
- Contaminated items that would release blood or OPIM in a liquid or semi-liquid state if compressed
- Items that are caked with dried blood or OPIM capable of releasing these materials during handling
- Contaminated sharps (e.g., needles, burs, scalpel blades, endodontic files)
- Pathologic and microbiologic wastes containing blood or OPIM

Regulated medical waste accounts for only 9% to 15% of total waste in hospitals and 1% to 2% of total waste in dental offices [10]. Examples of regulated waste found in dental practice settings are solid waste soaked or saturated with blood or saliva (e.g., gauze saturated with blood after surgery), extracted teeth, surgically removed hard and soft tissues, and contaminated sharp items, such as needles, scalpel blades, and wires [10]. General medical waste, including used gloves, masks, gowns, and lightly soiled gauze or cotton rolls, may be disposed of with ordinary waste.

Regulated 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 regulated medical wastes, provided the bag is sturdy and the waste can be discarded without contaminating the bag's exterior. Contamination or puncturing of the bag requires placement into a second biohazard bag. All bags should be securely closed for disposal.

Medical waste requiring storage should be kept in labeled, leak-proof, puncture-resistant containers under conditions that minimize or prevent foul odors. The storage area should be well-ventilated and inaccessible to pests. Any facility that generates regulated medical waste should have a regulated medical waste management plan to ensure health and environmental safety in accordance with federal, state, and local regulations [10; 21].

TRANSMISSION-BASED PRECAUTIONS

As discussed, Transmission-Based Precautions are used in addition to Standard Precautions for patients that require additional precautions to prevent infection transmission. The three categories of Transmission-Based Precautions are Contact, Droplet, and Airborne Precautions; these categories may overlap, and more than one category may be used at a time [25].

CONTACT PRECAUTIONS

Contact Precautions are utilized for patients with known or suspected infections that represent an increased risk for contact transmission. Contact Precautions require that practitioners [24]:

- Ensure appropriate patient placement to lessen risk for other patients or employees.
- Use PPE appropriately, including gloves and a gown. Donning PPE upon rom entry and properly discarding before exiting the patient room is recommended to contain pathogens.
- Use disposable or dedicated patient-care equipment such as blood pressure cuffs. If common equipment must be used for multiple patients, thoroughly clean and disinfect.
- Prioritize cleaning and disinfection of patient rooms and contact surfaces, focusing on frequently touched surfaces and equipment and objects in the immediate vicinity of the patient.

DROPLET PRECAUTIONS

Use Droplet Precautions for patients that are known or suspected to be infected with pathogens transmitted by respiratory droplets. Droplet Precautions requires that one [24]:

- Source control by putting a mask on the patient to prevent respiratory droplets from spreading.
- Ensure appropriate patient placement to lessen risk for other patients or employees.
- Use PPE appropriately, including gloves and a gown. Donning PPE upon rom entry and properly discarding before exiting the patient room is recommended to contain pathogens.
- Limit transport and movement of patients outside of the room, and if movement is necessary, instruct patient to wear a mask and follow Respiratory Hygiene/Cough Etiquette.

AIRBORNE PRECAUTIONS

Airborne Precautions are used when patients are known or suspected to be infected with pathogens transmitted by airborne or aerosol route. Airborne pathogens include TB, measles, chickenpox, and herpes zoster. Airborne Precautions require [24]:

- Source control by putting a mask on the patient to prevent respiratory droplets from spreading.

- Ensure appropriate patient placement in an airborne infection isolation room (AIIR) constructed according to the CDC's Guideline for Isolation Precautions. In settings where Airborne Precautions cannot be implemented due to limited engineering resources, masking the patient and placing the patient in a private room with the door closed will reduce the likelihood of airborne transmission until the patient is either transferred to a facility with an AIIR or returned home.
- Restrict susceptible healthcare personnel from entering the room of patients known or suspected to have measles, chickenpox, disseminated zoster, or smallpox if other immune healthcare personnel are available.
- Use PPE appropriately, including a fit-tested NIOSH-approved N95 or higher level respirator for healthcare personnel.
- Limit transport and movement of patients outside of the room, and if movement is necessary, instruct patient to wear a surgical mask and observe Respiratory Hygiene/Cough Etiquette. Healthcare personnel transporting patients who are on Airborne Precautions do not need to wear a mask or respirator during transport if the patient is wearing a mask and infectious skin lesions are covered.
- Immunize susceptible persons as soon as possible following unprotected contact with vaccine-preventable infections (e.g., measles, varicella or smallpox).

PROTECTING DENTAL HEALTHCARE WORKERS

Protecting dental professionals is an integral part of every dental organization's general program for infection prevention and control. The objectives usually include [5]:

- Educating personnel about the principles of infection control and emphasizing individual responsibility
- Providing care to personnel for work-related illnesses or exposures
- Identifying work-related infection risks and implementing appropriate preventive measures
- Containing costs by preventing infectious diseases that result in absenteeism and disability

OCCUPATIONAL EXPOSURES

An occupational exposure is defined as a percutaneous injury or contact of mucous membrane or nonintact skin with blood, tissue, or OPIM, most commonly a needlestick injury. The risk of infection depends on several factors, including [27]:

- Whether the exposure was from a hollow-bore needle or other sharp instrument
- Whether the exposure was to nonintact skin or mucous membranes
- The amount of blood involved
- The amount of contagion present in the source person's blood

If a sharps injury occurs, wash the exposed area with soap and water. Do not "milk" or squeeze the wound. There is no evidence that using antiseptics will reduce the risk of transmission for any bloodborne pathogens; however, the use of antiseptics is not contraindicated. In the event that the wound needs suturing, emergency treatment should be obtained.

The risk of contracting HIV from this type of exposure is extremely rare. There are no documented cases of a dental healthcare professional contracting HIV from an occupational exposure.

OSHA requires dental employers of an individual with an occupational exposure to a bloodborne pathogen to arrange a confidential medical evaluation and follow-up for any employee reporting an exposure incident [3]. An exposure incident is any eye, mouth, mucous membrane, nonintact skin, or other parenteral contact with blood or OPIM. Saliva in dental procedures is treated as potentially infectious material.

Following an exposure, the dental employer must refer the exposed employee to a licensed healthcare professional who can provide information and counseling and discuss how to prevent further spread of a potential infection. The exposed employee is entitled to appropriate follow-up and evaluation of any reported illness to determine if the symptoms may be related to HIV or hepatitis B or C infection [27].

Prompt response is necessary whenever an occupational exposure occurs. If possible, the patient should be interviewed to determine if any risk factors or bloodborne pathogens not previously disclosed are present. The patient may be tested along with the employee, if he or she agrees, in order to obtain the most information possible. Testing and postexposure prophylaxis may be conducted at an occupational injury clinic. All events leading up to and after the exposure should be documented in a written report [27].

Postexposure Prophylaxis

Postexposure prophylaxis (PEP) involves the provision of medications to someone who has had a substantial exposure, usually to blood, in order to reduce the likelihood of infection. PEP is available for HIV and hepatitis B virus. Although there is no PEP recommended for hepatitis C virus, limited data indicate that antiviral therapy might be beneficial when started early in the course of infection [28].

For employees who have not received the hepatitis B vaccine series, the vaccine (and in some circumstances hepatitis B immunoglobulin) should be offered as soon as possible (within seven days) after the exposure incident. The effectiveness of hepatitis B immunoglobulin administered more than seven days after exposure is unknown. PEP has been the standard of care for healthcare providers with substantial occupational exposures since 1996 and must be provided in accordance with the recommendations of the U.S. Public Health Service [28].

TUBERCULOSIS PREVENTION

To prevent the transmission of *Mycobacterium tuberculosis* in dental care settings, infection-control policies should be developed based on the community TB risk assessment and reviewed annually. The policies should include appropriate screening for latent or active TB disease in dental care providers, education about the risk for TB transmission, and provisions for detection and management of patients who have suspected or confirmed TB disease. The CDC recommends that all dental care providers be screened for TB upon hire, using either a tuberculin skin test or blood test [10].

Patients with symptoms of TB should be identified by screening; dental treatment should be deferred until active TB has been ruled out or the patient is no longer infectious following treatment. The potentially active TB patient should be promptly referred to an appropriate medical setting for evaluation of possible infectiousness and should be kept in the dental care setting only long enough to arrange for referral. Standard Precautions are not sufficient to prevent transmission of active TB [24].

A diagnosis of active respiratory TB should be considered for any patient with the following symptoms:

- Coughing for more than three weeks
- Loss of appetite
- Unexplained weight loss
- Night sweats
- Bloody sputum or hemoptysis

- Hoarseness
- Fever
- Fatigue
- Chest pain

A person with latent TB (positive skin test and no symptoms) can be treated in a dental office using standard infection control precautions [26]. This person has no symptoms and cannot transmit TB to others as there are no spores in his or her sputum.

The American Dental Association recommends that all patients be asked about any history of TB or exposure to TB, including signs and symptoms and medical conditions that increase their risk for TB disease. The Health History Form, developed by the U.S. Department of Health and Human Services, can be used to ask these questions.

If a patient with suspected or confirmed infectious TB disease requires urgent dental care, that care should be provided in a setting that meets the requirements for state, local, and employee standards for airborne infection isolation. Respiratory protection (with a fitted N95 disposable respirator) should be used while performing procedures on such patients. Standard surgical masks are not designed to protect against TB transmission [4; 26].

VACCINATION

Due to increased risk of occupational exposure, the CDC strongly recommends that all healthcare workers, including dental care providers, receive immunizations as a preventive measure. While these are the recommendations from the CDC, state and local legislation and workplace regulations may or may not require these immunizations.

Hepatitis B

The hepatitis B vaccine is given in a series of three injections at 0, 1, and 6 months. If one of the injections is missed, the series does not need to be restarted. The CDC recommends if the series is interrupted, the second or third dose should be administered as soon as possible; the second and third doses should be separated by an interval of at least eight weeks [24]. No booster is necessary. Follow-up serologic testing two months after vaccination (to ensure efficacy) is recommended. The provision of employer-supplied hepatitis B vaccination may be delayed until after probable exposure for employees whose sole exposure risk is the provision of first aid.

The high risk of hepatitis B virus exposure among healthcare personnel makes it imperative that clinical dental personnel be vaccinated. Vaccination can protect both workers and patients from hepatitis B virus infection and, whenever possible, should be completed when dentists or other dental care personnel are in training [10].

Influenza

Influenza is primarily transmitted from person to person via large, virus-laden droplets generated when infected persons cough or sneeze. These large droplets can settle on the mucosal surfaces of the upper respiratory tracts of susceptible persons who are within 3 feet of infected persons. Transmission may also occur through direct contact or indirect contact with respiratory secretions, such as when touching surfaces contaminated with influenza virus and then touching the eyes, nose, or mouth. The CDC strongly recommends that all healthcare personnel, especially those who have contact with patients at high risk, who have high-risk medical conditions, or who are older than 50 years of age, receive an annual (seasonal) influenza vaccination [24].

Measles, Mumps, and Rubella (MMR)

Vaccination for measles, mumps, and rubella is typically given in a single combination vaccine. The CDC notes that, regardless of birth year, individuals should receive two doses of measles, two doses of mumps, and one dose of rubella live-virus vaccine to be considered protected. MMR is given in a series of two injections, at least 28 days apart. Because the vaccine is often combination, most individuals will receive two doses of rubella-containing vaccine, with no adverse effect [24].

Tetanus and Diphtheria (Toxoids) and Acellular Pertussis (Tdap)

Vaccination for tetanus is recommended for all dental healthcare personnel, regardless of age. The CDC recommends receiving the vaccine as soon as feasible if Tdap has not already been received, and regardless of interval from the last tetanus and diphtheria (Td) immunization. Routine boosters are recommended every 10 years thereafter [24].

Varicella

The varicella-zoster virus is responsible for chickenpox and shingles. The CDC recommends the varicella-zoster vaccine for all dental healthcare personnel who do not have evidence of immunity, defined as: written documentation of two doses of varicella vaccine; laboratory evidence of immunity or confirmation of disease; diagnosis or verification of acute disease by a health-care provider; or diagnosis or verification of herpes zoster by a healthcare provider. While the varicella vaccine is recommended, the CDC does note that serologic testing before vaccination is likely to be cost-effective, as 71% to 93% of adults without a history of varicella are immune [24]. Immunization is considered complete after a series of two doses, spaced four to eight weeks apart [24].

TRAINING AND EDUCATION

Dental personnel should also fulfill all federal and state requirements for infection control training. New employees, or employees being transferred into jobs involving tasks or activities with potential exposure to blood or OPIM, must receive bloodborne pathogen training before assignment to tasks in which an occupational exposure may occur. Retraining is required annually or when changes in procedures or tasks affecting occupational exposure occur. Employees should be provided access to a qualified trainer to answer questions during the training session [9; 10].

CONCLUSION

Effective infection control techniques are critical to reducing the incidence of infections in dental facilities. Antiseptic techniques and antibiotics will kill micro-organisms, while proper hand hygiene will block their transmission. Gloves, gowns, and masks remove dental healthcare personnel from the transmission cycle by protecting them from contact with micro-organisms. Transmission-Based Precautions and isolation techniques help patients avoid being vectors of transmission. Engineering controls help to make the workplace safer, while administrative controls ensure that written protocols are in place and followed. Lastly, ensuring that all dental healthcare personnel are immune or vaccinated can help decrease the availability of potential hosts.

Works Cited

1. U.S. Bureau of Labor Statistics. Occupational Outlook Handbook: Dentists and Similar Occupations. Available at https://www.bls.gov/ooh/healthcare/dentists.htm. Last accessed December 15, 2024.
2. Occupational Safety and Health Administration. Worker Protections Against Occupational Exposure to Infectious Diseases. Available at https://www.osha.gov/bloodborne-pathogens/worker-protections. Last accessed December 15, 2024.
3. Occupational Safety and Health Administration. Standard 1910.1030: Bloodborne Pathogens. Available at https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.1030. Last accessed December 15, 2024.
4. California Department of Industrial Regulation. The California Workplace Guide to Aerosol Transmissible Diseases. Available at https://www.dir.ca.gov/dosh/dosh_publications/ATD-Guide.pdf. Last accessed December 15, 2024.
5. Centers for Disease Control and Prevention. Summary of Infection Prevention Practices in Dental Settings: Basic Expectations for Safe Care. Available at https://www.cdc.gov/dental-infection-control/hcp/summary/index.html. Last accessed December 15, 2024.
6. Centers for Disease Control and Prevention. Infection Control Basics. Available at https://www.cdc.gov/infection-control/hcp/basics/index.html. Last accessed December 15, 2024.
7. Mills SE, Porteous N, Zawada J. Dental unit water quality: Organization for Safety, Asepsis and Prevention white paper and recommendations. *Journal of Dental Infection Control and Safety*. 2018;(1)1:1-27.
8. World Health Organization. *Global Technical Consultation Report on Proposed Terminology for Pathogens that Transmit Through the Air*. Geneva: World Health Organization; 2024.
9. California Code of Regulations. Section 1005: Minimum Standards for Infection Control. Available at https://govt.westlaw.com/calregs/Document/IDB85BD734C8111EC89E5000D3A7C4BC3. Last accessed December 15, 2024.
10. Centers for Disease Control and Prevention. Guidelines for infection control in dental health-care settings—2003. *MMWR*. 2003;52(RR17):1-72.
11. World Health Organization. Five Moments for Hand Hygiene. Available at https://www.who.int/publications/m/item/five-moments-for-hand-hygiene. Last accessed December 15, 2024.
12. Centers for Disease Control and Prevention. Occupationally acquired HIV infection among health care workers–United States, 1985–2013. *MMWR*. 2015;63(53):1245-246.
13. Cheng HC, Peng BY, Lin ML, Chen SL. Hand hygiene compliance and accuracy in a university dental teaching hospital. *J Int Med Res*. 2019;47(3):1195-1201.
14. Centers for Disease Control and Prevention. Clinical Safety: Hand Hygiene for Healthcare Workers. Available at https://www.cdc.gov/handhygiene/science. Last accessed December 15, 2024.
15. Boles C, Parker J, Hallett L, Henshaw J. Current understanding and future directions for an occupational infectious disease standard. *Toxicology and Industrial Health*. 2020;36(9):703-710.
16. Occupational Safety and Health Administration. Bloodborne Pathogens and Needlestick Prevention: General Guidance. Available at https://www.osha.gov/bloodborne-pathogens/general. Last accessed December 15, 2024.
17. Armstrong-Novak J, Juan HY, Cooper K, et al. Healthcare personnel hand hygiene compliance: are we there yet? *Curr Infect Dis Rep* 2023;25:23-129.
18. Centers for Disease Control and Prevention. Dental Infection Prevention and Control: Best Practices for Personal Protective Equipment. Available at https://www.cdc.gov/dental-infection-control/hcp/dental-ipc-faqs/personal-protective-equipment.html. Last accessed December 15, 2024.
19. United States Department of Labor. Occupational Safety and Health Administration. 1910.132—General Requirements, Personal Protective Equipment. Available at https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.132. Last accessed December 15, 2024.
20. Porter L, Sultan O, Mitchell B, Kiernan M, et al. How long do nosocomial pathogens persist on inanimate surfaces? A scoping review. *J Hosp Infect*. 2024;147:25-31.
21. Rutala WA, Weber DJ, the Healthcare Infection Control Practices Advisory Committee. Guideline for Disinfection and Sterilization in Healthcare Facilities, 2008 (Update: June 2024). Available at https://www.cdc.gov/infection-control/media/pdfs/Guideline-Disinfection-H.pdf. Last accessed December 15, 2024.
22. U.S. Food and Drug Administration. Reprocessing of Single-Use Devices. Available at https://www.fda.gov/medical-devices/products-and-medical-procedures/reprocessing-single-use-medical-devices-information-health-care-facilities. Last accessed December 15, 2024.
23. U.S. Food and Drug Administration. Reprocessing of Reusable Medical Devices in Health Care Settings. Available at https://www.fda.gov/medical-devices/products-and-medical-procedures/reprocessing-reusable-medical-devices. Last accessed December 15, 2024.
24. Shefer A, Atkinson W, Friedman C, et al. Immunization of health-care personnel: recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR*. 2011:60(RR07):1-45.
25. Centers for Disease Control and Prevention. Transmission-Based Precautions. Available at https://www.cdc.gov/infection-control/hcp/basics/transmission-based-precautions.html. Last accessed December 15, 2024.

26. American Dental Association. Tuberculosis. Available at https://www.ada.org/resources/ada-library/oral-health-topics/tuberculosis-overview-and-dental-treatment-conside. Last accessed December 15, 2024.
27. Centers for Disease Control and Prevention. Best Practices for Occupational Exposure to Blood. Available at https://www.cdc.gov/dental-infection-control/hcp/dental-ipc-faqs/occupational-exposure.html. Last accessed December 15, 2024.
28. U.S. Public Health Service. Updated U.S. Public Health Service guidelines for the management of occupational exposures to HBV, HCV, and HIV and recommendations for postexposure prophylaxis. *MMWR.* 2001;50(RR11):1-52.
29. California Dental Association. New Infection Control Standard for Procedures that Expose Dental Pulp. Available at https://www.cda.org/newsroom/newsroom-archives/new-infection-control-standard-for-procedures-that-expose-dental-pulp/. Last accessed January 1, 2025.