REVIEW ARTICLE

Infection Control in Dental Clinics: Prosthodontics Perspectives

Bandar Mohammed Abdullah AL-Makramani

Abstract

Aim: The aim of this article is to discuss the infection control measures with focus on those related to prosthodontic work.

Background: The risk of transmission of several infectious microorganisms during dental procedures and the increased awareness and knowledge of infectious diseases have led to an increased attention to the importance of infection control. Prosthodontists and dental personnel are exposed directly or indirectly to a significant risk of acquiring healthcare-associated infections.

Review results: High standards of occupational safety and dental infection control must be applied by dental personnel for the safety of patients and dental healthcare workers. All reusable items (critical and semicritical instruments) that come in contact with the patient's saliva, blood, or mucous membranes must be heat-sterilized. Proper disinfectants should be used to disinfect nonsterilizable instruments (e.g., wax knifes, dental shade plastic mixing spatula, guides, fox bite plane, articulators, and facebows).

Conclusion: In prosthodontics, items potentially contaminated with patient's blood and saliva are transported between dental clinics and dental laboratories. Such fluids may contain microorganisms with high potential for transmission of several diseases. Therefore, sterilization and disinfection of all items used during prosthodontic work should be part of infection control protocol in dental care setting.

Clinical significance: In prosthodontic practice, a strict infection prevention plan should be implemented to minimalize the risk of infectious diseases transmission among prosthodontists, dental office, dental laboratory personnel, and patients.

Keywords: Disinfection, Infection control, Prosthodontists, Sterilization.

The Journal of Contemporary Dental Practice (2022): 10.5005/jp-journals-10024-3305

Introduction

The treatment offered to patients by a prosthodontist varies depending on the status of their dentition. Most of the dental patients need prosthodontics work. The treatment ranges from simple dental procedures like a dental impression to the more complicated such as maxillofacial rehabilitation. Providing a patient with a fixed dental prosthesis involves the use of sharp instruments which renders the prosthodontist to be susceptible to percutaneous injuries.[1]

Infection control in dental clinics is essential because the dental workers are at significant risk of acquiring infectious disease.[2,3] Elimination or reduction of spread of all types of infectious microorganisms is considered the main objective of infection control. It is the responsibility of a clinician to implement effective infection control policy to protect patients and all members of the dental team. Basically, two factors are important in infection control: the prevention of spread of microorganisms from their hosts and the killing or removal of microorganisms from objects and surfaces.[4]

A number of microorganisms existing in the dental clinic environment have been associated with serious and debilitating illnesses. Therefore, all efforts should be taken to prevent cross infection and to avoid any possible transmission of diseases during prosthetic dental work.[2,5]

In dental clinics, infections can be spread by blood or saliva, tooth debris, calculus, dental plaque, dental filling materials, direct or indirect contact, and aerosols generated during the dental treatment procedure.[6] Many dental procedures are associated with aerosol and splatter generation like prosthodontics teeth preparation, caries excavation, and periodontal scaling. The three main sources of air-borne contamination during dental treatment are saliva and respiratory sources, dental instrumentation, and the operative site.[7,8] It has been reported that the most intensive and highly concentrated aerosol and splatter arises from the tip of the ultrasonic scaler and the attached bur on a high-speed handpiece.[8–10] Infectious microorganisms can remain suspended in the air and cause serious health problems for patients and dental clinic staff like common cold, pneumonia, TB, herpes, SARS, coronavirus disease-2019 (COVID-19), as well as skin and eye infections.[6,7] Many of the known infectious diseases have been prevented by vaccination but it is important to observe measures that reduce the chances of transmission in a dental office setting.[11]

Prosthodontists face a high risk of acquiring infectious diseases from their patients because of the close proximity to the patient with exposure to contaminated droplets and aerosols generated during dental treatment procedures. They are also at risk of indirect cross infection through exposure to saliva-contaminated surfaces

Department of Prosthetic Dental Sciences, College of Dentistry, Jazan University, Jazan, Saudi Arabia; Department of Restorative Dentistry, Faculty of Dentistry, Sana'a University, Sana'a, Yemen

Corresponding Author: Bandar Mohammed Abdullah Al-Makramani, Department of Prosthetic Dental Sciences, College of Dentistry, Jazan University, Jazan, Saudi Arabia, Department of Restorative Dentistry, Faculty of Dentistry, Sana'a University, Sana'a, Yemen, Phone: +966568557923, e-mail: makramani@yahoo.com

How to cite this article: AL-Makramani BMA. Infection Control in Dental Clinics: Prosthodontics Perspectives. J Contemp Dent Pract 2022;23(9):953–961.

Source of support: Nil

Conflict of interest: None

as well as indirect contact with dental laboratories items including impressions, dental stone casts, and fixed and removable prosthesis. Consequently, very meticulous measures and precautions should be considered in the dental clinic.

Definitions[12]

Disinfection: It is the process of using chemicals that kill the growing forms (vegetative forms) but not the resistant spores of bacteria. This uses chemical germicides, radiation, ultraviolet rays, or heat.

Disinfectant: It is a chemical substance, which causes disinfection. It is used on nonvital objects to kill surface vegetative pathogenic organisms, but not necessarily spore forms or viruses.

Sterilization: It involves any process, physical or chemical, that will destroy all forms of life, including bacterial, fungi, viruses, and bacterial endospores. Sterilization kills all bacteria, fungi, virus, and bacterial endospores. It uses chemical methods and physical methods.

Routes of Disease Transmission

In order to better apply the principles of disinfection and sterilization and to stop the spread of infectious microorganisms, it is important to know the mode of transmission and possible problems of these infectious microorganisms. The diseases caused by microorganisms are of bacterial, viral, fungal, or protozoal origin. For infection to take place, the host must first acquire these infective microorganisms.[5]

The routes of transmission of disease can be specific to different clinical specialties. In dentistry, diseases may spread from dentist to patient, from patient to dentist, from one patient to another, and from dentist to dental technician, if proper precautions are not taken. Dental professionals and patients can spread illnesses to their family, friends, and community. The common routes of transmission of disease according to severity are:[2,5,13]

- *Percutaneous injury (high-risk route)*
  In this, spread of microorganisms from blood and saliva occurs through needles and sharp injuries.
- *Contact (high-risk route)*
  In this, the microbes are transferred through touching or exposing the injured skin to contaminated fluids, infectious tissue surfaces, infectious oral lesions, and splashes of infected fluids.
- *Inhalation of pathogen-containing aerosols or droplets (moderate risk route)*
  In this, inhalation of pathogen-containing aerosols or droplets can occur through breathing of suspended bioaerosols in clinics air burdened with infectious pathogen during the use of dental handpiece and scalers or cough droplet.
- *Indirect contact through fomites (low-risk route)*
  It is very rare and can occur through contacting contaminated nonliving surfaces in the dental clinic or laboratory.

Several studies have been conducted to discover the category of microorganisms mainly present in some of the prosthodontics items sent to the dental laboratories. Those studies found that there are specific microorganisms for some items. *Staphylococcus* species, α-hemolytic streptococci, *Micrococci*, *Diphtheria*, *Pseudomonas*, *Bacilli*, *Enterobacter*, *Neisseria*, *Corynebacterium* species, were detected on alginate impressions, rubber-base impressions, dental stone cats, wax occlusal rims, crowns, dentures, and relining materials.[2,5]

Categorization of Instruments for Infection Control[14]

Many instruments and materials used in the dental surgery and dental laboratory can be a source of cross infections. Based on Spaulding classification,[15] the center for disease control and prevention (CDC) classified the dental instrument into critical, semi-critical, and noncritical according to the risk of disease transmission (Table 1).[14]

Cross Infection in Prosthodontic Clinics

Cross infection is the transmission of infectious agents among patients and staff within a clinical environment. This source of infection can be:

- Patients suffering from infectious diseases
- Patients who are in the prodromal stage of infections
- Healthy people who are carrying the infection

Infectious microorganisms are always present in patient's blood and saliva. Thus, contact with blood or saliva should be avoided to prevent the spread of microorganisms. In prosthodontics, items potentially contaminated with infectious microorganisms are transmitted between dental clinic and laboratory.[5,16] In prosthodontics work, impressions, dental stone casts, impression trays, bite records, wax rims, articulators, and

Table 1: Categorization of instruments involved in infection transmission[14]

Instrument	*Exposure type*	*Example*	*Method of sterilization*
Critical	Items used in invasive procedures which penetrate oral mucosa, bone, enter or contact blood or other sterile tissue, and are nondisposable	Scalpel blades, dental burs, extraction forceps, files, periodontal instruments, surgical drains, dental explorer, periodontal probes, biopsy punch, endodontic file reamer and implants	Should be sterilized after single use by help of autoclave, dry heat, chemical vapor
Semicritical	Does not penetrate soft tissue or bone but come into contact with intact mucous membrane and saliva	Mouth mirrors, handpiece, anesthetics syringe, amalgam condenser, reusable impression trays, air/water syringe tips and high-volume evacuator tips	Should be sterilized after each use. If sterilization is not applicable, disinfection with high-level disinfectant should be done or barrier should be used
Noncritical	Surface which penetrates neither tissue nor contact with mucous membrane but come in contact with intact skin	Chair light handles, instrument trays, high-touch work surface, chair control and dental chairs, external components of X-ray heads, sphygmomanometer cuffs, pulse-oximeter	Requires intermediated to low level of disinfection after cleaning. It is done by hydrogen peroxide bases, phenols, iodophors

facebow could spread infectious microorganisms to the dental laboratory personnel.[2,16] It has been reported that microorganisms are communicated from impressions to casts and from dentures to pumice.[17,18]

Analysis of prosthodontic setups shows that many instruments and support equipment carry the potential to transmit diseases. The main sources of transmission of infection from patient to dental technicians are impressions, impression trays, and stone casts. In addition, the dental prostheses at different stages of try-in and delivery can transmit infection from dental clinic to patient or dental laboratory. Other items used by prosthodontists and can cause a problem include mixing spatulas, shade guides, rulers, indelible pencils, knives, contaminated prosthesis returned from laboratory, face bows, articulators, and torches.[12,16]

Infection Control Measures in Prosthodontic Clinics (Table 2)[2,13,19]

In prosthodontics, many contaminated objects and equipment are transferred between the dental clinic and laboratory. Thus, it has been claimed that to avoid cross infection, precise disinfection measures must be applied.[2]

Applying realistic and safe infection control measures requires the full obedience of the whole dental team. These measures must be observed frequently during clinical sittings and discussed at practice meetings. Establishing and maintaining effective and comprehensive infection control programs is a requirement of dental clinics and dental laboratories. These programs should be regularly checked and monitored for compliance with the time standards. All patients should be treated using universal precaution. There should be no exception and no extra precaution for specific patients. By practicing infection control, patients as well as operator can be protected. High standards of occupational safety and dental infection control must be applied by dental personnel for safety of the patients and dental healthcare workers.[5,11]

There are seven basic infection control measures required to control infection in dental clinic practice. The following are the commonly required measures:[5,19,20]

- All dental workers must wear latex gloves while examining and treating patients.
- All dental workers must wear a face mask that covers the nose and mouth during the treatment given to patients.
- All dental workers must wear eye-protective glasses while treating a patient.
- All instruments used in the patient's mouth must be appropriately sterilized. Recommended systems in dental practice are dry heat, chemical vapor, and steam sterilizations.
- All touch surfaces must be disinfected using agents such as sodium hypochlorite, glutaraldehyde, iodophor, and synthetic phenols.
- All contaminated materials must be carefully placed and disposed in sealed and properly labeled containers.
- Immunization programs must be planned for effective immunization against infectious diseases like hepatitis virus, HIV, SARS-CoV-2 (COVID-19), influenza, chickenpox.

Instrument and Equipment Decontamination

Appropriate disinfectants should be used to disinfect nonsterilizable instruments (e.g., wax knifes, dental shade guides, plastic mixing spatula, Fox bite plane, articulators, and facebows). Chemical disinfectants can be classified into three levels depending on their activity against Mycobacterium tuberculosis, vegetative bacteria, spores, and viruses. The three levels of disinfection are: high level, intermediate level, and low level.[5,14,21] High-level disinfectants are effective against spores and all microbial forms. Glutaraldehyde solutions and ethylene oxide gas are commonly used as high-level disinfectants. Intermediate-/medium-level disinfectants are effective against microorganisms like *Mycobacterium tuberculosis* but with no effect on spores. A commonly used intermediate-/medium-level disinfectants include iodophors, chlorine compounds, formaldehyde, phenols, and alcohols. Low-level disinfectants are chemical agents with a narrow range of antibacterial activity and not recommended for disinfection of dental impressions.[22] Detergents, quaternary

Table 2: Infection control measures involved in prosthodontic clinics[2,13,19]

A. Patient screening: Reviewing the medical history of the patients is a must at the beginning of each dental appointment. An initial screening of the patient by a prosthodontist should be performed during the examination and history taking phase prior to any dental treatment procedure. This is attained through designing a specific medical history to easily categorize patients who are usually susceptible to infection or at high risk of spreading infection.
B. Personal hygiene: The personal hygiene of the dentist is considered an absolute requirement to avoid spread of infection.
C. Personal protection: The infectious disease acquisition and transmission can be greatly reduced by vaccination, use of protective eyeglasses, long sleeve medical coat with high collar, protective face shields, masks, and latex gloves. Cuts and abrasions should be kept covered and punctured gloves should be changed.
D. Instrument processing: We should always be aware that the use of disposable tools and equipment is encouraged whenever possible. Any instrument that has been used in the patient's mouth should be thoroughly cleaned in the ultrasonic bath prior to autoclave sterilization. Nonsterilizable devices should be disinfected using chemical disinfectants.
E. Surface asepsis: Surface asepsis can be achieved by two common methods: the use of surface barriers to prevent the surface from becoming contaminated and by cleaning and disinfecting contaminated surfaces. Both methods can also be used together.
F. Patient treatment: Responsibility for infection control measures during a patient's treatment depends mainly on the ability of the dentist to adhere to strict disinfection, sterilization, and surface barrier methods.
G. Laboratory disinfection: In the dental laboratory, all checked-in and checked-out prostheses should be disinfected. In addition, each patient's prostheses should be kept separate through disinfection, sterilization, and barrier systems. All received prostheses should be cleaned with a chemical disinfectant. All prosthetics leaving the dental laboratory should be immersed in a solution of 5.25% sodium hypochlorite for at least 10 minutes.

ammonium compounds, and simple phenols are considered as low-level disinfectants.[21]

The dental disinfectants most commonly used come under intermediate level of disinfection. In order to exceed a minimum standard level of intermediate disinfection, a high-level disinfectant like glutaraldehyde can be used.[5,19] Commonly used dental disinfectants are alcohols, iodophors, phenols, glutaraldehyde, quaternary ammonium compounds, formaldehyde, chlorhexidine, halide disinfectants such as hypochlorite and bromides. These disinfectants can be used by either spraying or immersion technique.[14,23,24]

Whenever possible disposable instruments must be used, it is recommended that all instruments used in the patient mouth must be thoroughly cleaned using ultrasonic cleaner before autoclave sterilization.[25] All reusable items (critical and semi-critical instruments) that come in contact with the patient's blood, saliva, or mucous membranes must be heat-sterilized. The most common forms of heat sterilization in the dental office are:[14,26,27]

- Moist/steam heat sterilization
- Dry heat sterilization
- Chemical vapor pressure sterilization
- Ethylene oxide sterilization

Moist/Steam Heat Sterilization (Autoclave)[14,26,27]

It is a reliable and efficient way for dental instruments sterilization by steam generation in a closed chamber producing a moist heat that quickly kills microorganisms. The time required at 121°C is 15 minutes under a pressure of 15 PSI.

Advantages

- Short time of sterilization
- Allows good penetration of steam
- It shows consistently good and reliable results
- The instruments can be wrapped
- Water-based liquids can be sterilized

Disadvantages

- Damage to items which are sensitive to the high temperature like plastic and rubber items
- Blunting and rust of carbon steel burs and sharp instruments
- Wet instruments after sterilization cycle

Dry Heat Sterilization[14,26,27]

It is an alternative way for sterilizing dental instruments. It needs higher temperatures than other heat sterilizers and runs at approximately 320–375°F (160–190°C) with time range of 60–120 minutes, depending on the type of sterilizer. There are two types of dry heat sterilizers (static air and forced air). Static air sterilizers: it is almost like a conventional oven and uses radiating dry heat for sterilization. Using this type of sterilizers requires a longer exposure with high temperature because of poor conduction of heat and poor penetration capacity. Forced air sterilizers: also called a rapid heat transfer sterilizer. It uses a fan circulating the hot air in the chamber at a high speed which permits a rapid transfer of heat energy to the instruments from the air, thus reducing the time required for sterilization.

Advantages

- No rust or corrosion of burs and carbon-steel instruments if *thoroughly dried prior to* sterilization
- No effect on the sharpness of cutting instruments
- Low cost
- Obtaining dry Instruments after sterilization cycle
- Safe and effective for sterilization of mirrors and metal instrument
- Rapid cycles at high temperatures are possible

Disadvantages

- Heat-sensitive items may be damaged at high temperatures, like plastic or rubber goods
- Long cycle is needed because of poor penetrating capacity and poor heat conduction
- It is a must to thoroughly dry instruments prior to sterilization
- Not recommended for sterilization of heat-sensitive handpieces because the excessive heat will damage bearings
- Cannot sterilize liquid
- Must be monitored and calibrated to avoid errors in sterilization

Chemical Vapor Sterilization[14,26,27]

It is similar to autoclaving, except a special chemical solution (0.23% formaldehyde + 72.38% ethanol + acetone + water and other alcohols) is heated in a closed chamber and used instead of water to create a hot chemical vapor for sterilizing. For a completion of one cycle, a temperature of 270°F (132°C) at 20 lb pressure for 30 minutes are required.

Advantages

- No rust or corrosion of carbon steel burs and instruments
- Dry instruments after sterilization
- Short sterilization cycle

Disadvantages

- Damage of sensitive items to higher temperature
- Offensive odor of the vapor which requires good ventilation
- Not recommended for sterilization of paper towels, liner, and heavy clothing as it may absorb chemicals
- Needs special chemical solutions and cannot sterilize liquids
- Instruments must be dried before loading them in the chamber

Ethylene Oxide Sterilization[14,26,27]

This method of sterilization is recommended for sterilizing delicate materials and complex instruments. Ethylene oxide is noncorrosive gas above 10.8°C, has a high penetration capacity, and has a cidal action for bacteria, spores, and viruses.

Advantages

- No offensive odor
- Better penetration capability
- Can be operated at a lower temperature
- Appropriate for heat sensitive items like rubber and plastic

Disadvantages

- High cost
- Toxicity of the gas
- Flammable and explosive

Infection Control: Prosthodontic Perspectives

Disinfection of Impression Materials

Dental impression materials are classified into rigid or nonelastic (e.g., impression compound and zinc oxide eugenol) and elastic

Table 3: Recommended disinfection method for the impression material[19,21,23,24,28,36,37]

Impression material	*Recommended method of disinfection*
Zinc oxide eugenol and impressions compound	• Immersion in a solution of 2% iodophor for 20 minutes. • Immersion in a solution of 2% glutaraldehyde for 10 minutes.
Alginate	• Spray it using sodium hypochlorite, rinse, spray it again and keep it for 10 minutes in a wet gauze or in a sealed plastic bag. • Immerse it in a 2% glutaraldehyde solution for 10 minutes.
Agar	• Spray it using sodium hypochlorite, rinse it, spray it again and keep it for 10 minutes in a wet gauze or in a sealed plastic bag.
Polysulfide	• Rinse it under running water for 45 seconds and immerse it in a 2% glutaraldehyde solution for 30 minutes. • Immerse it in a solution of 5.25% sodium hypochlorite for 15 minutes and then rinse it in water.
Addition silicone materials (PVS)	• Immerse it in a 2% glutaraldehyde solution for 1 hour and then rinse it with water.
Condensation silicone materials	• Immerse it in a 2% glutaraldehyde solution for 10 minutes and then rinse it with water.
Polyether	• Immerse it for 1 hour in a 2% glutaraldehyde solution at room temperature and then rinse it with water for 45 seconds and dry it for 10 minutes.

impression materials (e.g., aqueous hydrocolloids and nonaqueous elastomers). In prosthodontics, most procedures are done using elastic impression materials including irreversible hydrocolloids (alginate) and nonaqueous elastomers (addition silicones, condensation silicones, polysulfides, and polyether).

Impressions are highly contaminated with patient saliva or blood which may have viral and bacterial pathogens. Hence, impressions can act as a vehicle for transmission of different types of microorganisms from the patient's mouth to dental personnel and to dental technicians. It has been stated that alginate impressions produced a significantly higher level of contamination compared to polyvinyl siloxane (PVS) and polyether impressions from the same individual.[28]

Consequently, impressions should be disinfected before sending to the dental laboratory. To avoid cross infection, impression should be rinsed thoroughly after removal from the mouth to remove as much blood or bioburden as possible prior to disinfection. The impression is then disinfected using an EPA (Environmental Protection Agency)-registered disinfectant. After disinfecting the impression, it must be rinsed thoroughly to remove disinfectant which may result in a substandard cast due to incorporation of residual disinfectant into the pouring plaster or stone. Exposing an impression to a disinfectant solution by spraying or immersion for various lengths of time after rinsing saliva and blood are the procedures chiefly advocated.[28,29]

There are important characteristics of impression materials like hydrophilicity, the use of surfactant, and their tolerance of immersion in water or other fluids. These characteristics are important in understanding the disinfection protocols suitable for each impression material. For example, polyether is hydrophilic and has a tendency to distort and absorb moisture. There is also a concern with immersion disinfection regarding the dimensional stability of impression materials, especially irreversible hydrocolloids (alginate) because an adequate time should be given to disinfect the impressions before pouring.[24]

Disinfection of impressions by immersion is favored over spraying. Spraying may not be effective because constant contact of the disinfectant with all surfaces of the impression cannot be assured. To prevent possible distortion of the impressions and according to the manufacturers' directions, a disinfection time of 10 minutes or less for the immersion disinfection and 15 minutes of contact time for the spraying disinfection were recommended.[28,30] Different studies reported complete removal of microorganisms from different impression materials following exposure to various disinfectant solutions.[31–34]

A recent systematic review and meta-analysis of *in vitro* studies reported that disinfection of alginate with sodium hypochlorite, chlorhexidine, glutaraldehyde, and alcohol reduced the colony-forming units by a milliliter (CFU/mL) on the surface of alginate impressions. This trend was observed when PVS impressions were disinfected with glutaraldehyde, sodium hypochlorite, and alcohol and when polyether was immersed in alcohol or glutaraldehyde. Therefore, these substances could be employed to reduce cross-contamination in the dental office.[35] Table 3 summarizes the recommended disinfection method by impression material.[19,21,23,24,28,36,37]

Disinfection of Casts and Models

Disinfection of casts and models is considered an ideal practice to prevent the cross infection. Though, the casts that were obtained from suitably disinfected impressions can later become infected during laboratory and clinical procedures. After try-in, the prosthetic device can be contaminated by the patient. In addition, the cast can be contaminated again during adjusting the prosthesis in the patient's mouth.[5,21] Contaminated stone casts are difficult to be chemically disinfected. If avoiding cross-contamination is considered a requirement, disinfection procedures should be applied throughout the treatment period for both the prosthesis and the cast.[5,38]

Different methods have been used to disinfect casts and models including spraying with disinfectant, immersion in a disinfectant solution, incorporating of disinfectants with dental stone, and using microwave oven.[17,39] Several *in vitro* studies stated that the immersion in 0.525% NaOCl shows no adverse effect on surface detail reproduction, dimensional accuracy, and compressive strength of casts.

Another indicated method for cast decontamination is the microwave irradiation.[40] It is reported that autoclaving of the casts may result in a poor reproduction of the surface details, and immersion of the cast in disinfectant chemical solution may dissolve gypsum, thus diminishing the compressive strength of the casts. Therefore, microwave oven disinfection is considered a convenient

solution.[41] However, it has been reported that microwave irradiation adversely affects the strength of casts after 1 hour of pouring, and this effect diminished after 24 hours. Therefore, when using microwave irradiation, it is preferred to wait for 24 hours before disinfecting dental casts.[42]

Dental Prostheses

Orally soiled prostheses may have abundant amounts of calculus and other persistent bioburden. The prostheses should be cleaned from debris for effective decontamination. Debris and contamination are removed first from the prostheses by scrubbing with brush and antimicrobial soap. Then, place it in sealed plastic bags or beakers filled with ultrasonic cleaning solution to remove calculus. Remove the prostheses, rinse it under running water, and dry it before disinfection.[16]

Ticonium alloy should not be in contact with a concentrated solution of sodium hypochlorite for longer than 15 minutes. To minimize corrosion, care should be taken to avoid exceeding the manufacturer's recommended contact time for metal components. There is little effect on chrome-cobalt alloy with short-term exposures (10 minutes). If a removable partial denture (RPD) must be immersed for periods longer than 15 minutes or repeatedly soaked in sodium hypochlorite, vitallium alloy is considered the metal of choice because of its proved ability to resist tarnish or corrosion after 24 hours of immersion.[43]

McGowan et al. stated that exposure of both vitallium and ticonium alloys to either 5.25% sodium hypochlorite solution for 3 minutes or 2% sodium hypochlorite solution for 5 minutes will not have any harmful effects on these metals.[43] Brace and Plummer reported that using a 15-second scrub with 4% chlorhexidine followed by 3 minutes of contact time with sprayed chlorine dioxide is an effective, simple, and time-efficient method for denture disinfection.[44] This is supported by another study which has shown that 1% sodium hypochlorite had the best antimicrobial effectiveness against the tested microorganisms (*Candida albicans*, *Streptococcus mutans*, *Escherichia coli*, *Staphylococcus aureus*, and *Bacillus subtilis*).[45] Dental prostheses should be stored in diluted mouthwash and not in disinfectant before insertion.[16]

Table 4 summarizes the infection control protocol for acrylic dentures, RPD frameworks, and other items commonly used during prosthodontic work.[5,19,43,44,46–49]

Recent Advances in Infection Control in Dentistry

In the field of dental infection control, the advance of best practices and regulatory requirements have been realized and encouraged the use of heat sterilization as the gold standard for all dental equipment and instruments. The use of heat sterilization combined with the increased use of disposable products and film barriers has placed dentistry at the head of medical healthcare providers in terms of sterilization. Recently, dental manufacturers have started supplying instrument washers/disinfectors for use in a typical dental practice which has only been in use for many years in a large institutional and medical facility setting. This device is an effective method for presterilization cleaning of contaminated dental instruments and offers high-level disinfection during the cleaning process.[50–52]

Conventional immersion and spray disinfection agents used to disinfect alginate impression materials may result in dimensional changes. To avoid dimensional changes and inaccuracies of alginates impression materials following conventional disinfection process, manufacturers have combined disinfectant agents into the alginate. The added disinfectants must be effective enough without affecting the physical properties, stability, accuracy, and the pouring of the taken impression.[34] Generally used disinfecting agents are water-soluble and dispersible components. These agents include chlorhexidine, dialkyl quaternary compounds, quaternary ammonium compounds, quinoline compounds, bisquanidine compounds, didecyldimethyl ammonium chloride, substituted phenols, or a mixture of these agents.[53]

Disinfectant agents can be mixed with or coated onto the alginate powder. Attempts have been done to use disinfectant agents in the form of microcapsules and incorporate them into the alginate. The disinfectants will be released during mixing these microcapsules with the liquid. Alternatively, efforts have also been made to use the disinfectant agents in the form of solution and add it to the mixing liquid. Researchers have investigated the efficacy of different disinfectant solutions like sodium hypochlorite and chlorhexidine and proved that chlorhexidine was effective without influencing the flowability, setting time, accuracy, and dimensional stability of alginate impression materials.[54,55]

Recently, self-disinfecting alginate impression materials have been developed by adding antimicrobial nanosilver particles.

Table 4: The infection control protocol for acrylic dentures, RPD frameworks, and other items commonly used during prosthodontic work[5,19,43,44,46–49]

Acrylic dentures	• Rinse it under running water, clean all debris by placing it in an ultrasonic path, and then immerse it in an alkaline glutaraldehyde solution for 12 hours. • Rinse it under running water and scrub it for 15 seconds using 4% chlorhexidine. Then spray it with chlorine dioxide for a contact time of 3 minutes and rinse it in water. • Can be sterilized using ethylene oxide gas with a concentration of 450–800 mg/L.
Metal framework	• By immersion in a solution of 5.25% sodium hypochlorite for 3 minutes and then rinse it in water.
Pumice	• By adding an antiseptic, which contains octenidine, to the conventional pumice. • Benzoic acid can also be added to the conventional pumice. • The used pumice must be discarded after each use.
Wax bites, occlusal rims, bite registrations	• Immersion in a solution of 5.25% sodium hypochlorite and then place it a sealed plastic bag for 10 minutes.
Cutting burs (diamond steel, carbon)	• Place in a dry heat oven for 1 hour at 60°C. • Using chemical vapor for 20 minutes at 270°F. • Can be sterilized using ethylene oxide gas with a concentration of 450–800 mg/L.

(Contd...)

Table 4: *(Contd...)*

Dapen dishes	• Using steam autoclave for 15–20 minutes at 121°C and 15 lb/in^2. • Can be sterilized using ethylene oxide gas with a concentration of 450–800 mg/L.
Mixing glass slabs	• Using steam autoclave for 15–20 minutes at 121°C and 15 lb/in^2. • Using dry heat oven for 1 hour at 160°C. • Using chemical vapor for 20 minutes at 270°F. • Can be sterilized using ethylene oxide gas with a concentration of 450–800 mg/L.
Hand instruments made from carbon steel	• Using dry heat oven for 1 hour at 160°C. • Using chemical vapor for 20 minutes at 270°F. • Can be sterilized using ethylene oxide gas with a concentration of 450–800 mg/L.
Stainless steel	• Using steam autoclave for 15–20 minutes at 121°C and 15 lb/in^2. • Using dry heat oven for 1 hour at 160°C. • Using chemical vapor for 20 minutes at 270°F. • Using ethylene oxide gas with a concentration of 450–800 mg/L.
Handpieces	• As per manufactures instructions. • Can be sterilized using ethylene oxide gas with a concentration of 450–800 mg/L. • Using steam autoclave for 15–20 minutes at 121°C and 15 lb/in^2.
Metal impression trays (aluminum and chrome-plated)	• Using steam autoclave for 15–20 minutes at 121°C and 15 lb/in^2. • Using chemical vapor for 20 minutes at 270°F. • Can be sterilized using ethylene oxide gas with a concentration of 450–800 mg/L.
Custom acrylic resin tray	• Discard after intraoral use in a patient; disinfect with tuberculocidal hospital disinfectant for reuse during the same patient's next visit.
Disposable plastic trays	• Should be discarded after each single use in patient mouth.
Mouth and face mirrors	• Can be sterilized using ethylene oxide gas with a concentration of 450–800 mg/L. • Using dry heat oven for 1 hour at 160°C. • Using chemical vapor for 20 minutes at 270°F. • Using ethylene oxide gas with a concentration of 450–800 mg/L.
Polishing disks and wheels	• Can be sterilized using ethylene oxide gas with a concentration of 450–800 mg/L.
Saliva ejectors and evacuators	• Can be sterilized using ethylene oxide gas with a concentration of 450–800 mg/L.
Water-air syringe tips	• Using steam autoclave for 15–20 minutes at 121°C and 15 lb/in^2. • Using dry heat oven for 1 hour at 160°C. • Using chemical vapor for 20 minutes at 270°F. • Using ethylene oxide gas with a concentration of 450–800 mg/L.
X-ray machine	• Can be sterilized using ethylene oxide gas with a concentration of 450–800 mg/L. • As per manufactures recommendation.

Different studies have reported that these nanosilvers were effective against *Pseudomonas aeruginosa*, *Lactobacillus acidophilus*, *S. aureus*, and *Actinomyces viscosus*.[56,57]

In addition, the antimicrobial activity of copper oxide and zinc oxide nanoparticles was investigated by many investigators and found that these antimicrobial nanoparticles were also effective as a self-disinfecting agent for alginate impression materials without any influence on the handling and mechanical characteristics.[58]

Conclusion

The aim of dental infection-control is to provide a safe working environment that will reduce the risk of cross infection among dentists, patients, auxiliary staff, and dental laboratory technicians. Prosthodontists are at high risk of acquiring infection because of continuous exposure to aerosols and potentially contaminated surfaces. In addition, they along with dental laboratory technicians are at high risk of infection through indirect contact with impressions, casts, and removable and fixed prosthesis. Therefore, sterilization and disinfection of all items used during prosthodontic work should be a crucial part of infection control practice in dental clinics.

References

1. Al Makramani BM, Al Sanabani F, Mattoo KA. Reviewing infection control in prosthodontic practice with a case of herpes simplex in the times of a corona virus pandemic. Ann Rom Soc Cell Biol 2021;25(6):10898–10904. https://www.annalsofrscb.ro/index.php/journal/article/view/7554.
2. Nirmal Raj APKS, Raju V, Darshan V. Infection control in prosthodontics: a review. URJDS 2015;2(1):6–7. http://ujponline.com/urjds/past-issues/universal-research-journal-of-dental-sciences-volume-2-issue-1-2015/.
3. Huber MA, Terezhalmy GT. HIV: infection control issues for oral healthcare personnel. J Contemp Dent Pract 2007;8(3):1–12. PMID: 17351676.
4. Habboush Y, Yarrarapu S, Guzman N. Infection control. [Updated 2021 Sep 13] In: StatPearls [Internet] Treasure Island (FL): StatPearls Publishing; 2022. Available from: https://wwwncbinlmnihgov/books/NBK519017/2021.
5. Kumar RNKK, Maller SV. Infection control in prosthodontics. JIADS 2010;1(2):22–24.
6. Jain M, Mathur A, Mathur A, et al. Qualitative and quantitative analysis of bacterial aerosols in dental clinical settings: risk exposure towards dentist, auxiliary staff, and patients. J Family Med Prim Care 2020;9(2):1003. DOI: 10.4103/jfmpc.jfmpc_863_19.

7. Harrel SK, Molinari J. Aerosols and splatter in dentistry: a brief review of the literature and infection control implications. J Am Dent Assoc 2004;135(4):429–437. DOI: 10.14219/jada.archive.2004.0207.
8. Matys J, Grzech-Leśniak K. Dental aerosol as a hazard risk for dental workers. Materials 2020;13(22):5109. DOI: 10.3390/ma13225109.
9. Leggat PA, Kedjarune U. Bacterial aerosols in the dental clinic: a review. Int Dent J 2001;51(1):39–44. DOI: 10.1002/j.1875-595x.2001.tb00816.x.
10. Szymanska J. Dental bioaerosol as an occupational hazard in a dentist's workplace. Ann Agric Environ Med 2007;14(2):203–207. PMID: 18247451.
11. BDA. Infection control in dentistry. 2003, Advice Sheet.
12. Asad T, Tareen A. Avoiding cross contamination; a protocol for prosthodontic clinics and labs. Pak Oral Dent J 2002;22:159–160. http://podj.com.pk/archive/PODJ/.
13. Rampal N, Pawah S, Kaushik P. Infection control in prosthodontics. J Oral Health Comm Dent 2010;4(1):7–11. https://www.johcd.net/doi/JOHCD/pdf/10.5005/johcd-4-1-7.
14. Rutala WA, Weber DJ. Disinfection, sterilization, and control of hospital waste. In: Mandell, Douglas, and Bennett's principles practice of infectious diseases. 2015. p. 3294.
15. Spaulding EH. Chemical disinfect of medical and surgical materials. In: Disinfection, sterilization and preservation. 1968. p. 517–531.
16. Bhat VS, Shetty MS, Shenoy KK. Infection control in the prosthodontic laboratory. J Indian Prosthodont Soc 2007;7(2):62. DOI: 10.4103/0972-4052.33997.
17. Leung RL, Schonfield SE. Gypsum casts as a potential source of microbial cross contamination. J Prosthet Dent 1983;49(2):210–211. DOI: 10.1016/0022-3913(83)90503-6.
18. Williams H, Falkler Jr W, Hasler J, et al. Persistence of contaminant bacteria in dental laboratory pumice. Quintessence Dent Technol 1986;10(6):385–388. PMID: 3016800.
19. Naveen B, Kashinath K, Jagdeesh K, et al. Infection control in prosthodontics. J Dent Sci Res 2011;2(1):93–107. https://scholar.google.com/scholar_lookup?journal=J+Dent+Sci+Res&title=Infection+control+in+Prosthodontics&author=BH+Naveen&author=K+Kashinath&author=KN+Jagdeesh&author=RB+Mandokar&volume=2&publication_year=2011&pages=93-107&.
20. Runnells R. An overview of infection control in dental practice. J Prosthet Dent 1988;59(5):625–629. DOI: 10.1016/0022-3913(88)90083-2.
21. Mantena S, Mohd I, Sajjan S, et al. Disinfection of impression materials: a comprehensive review of disinfection methods. Int J Dent Mater 2019;1(1):07–16. DOI: 10.37983/IJDM.2019.1102.
22. Molinari J, Runnells R. Role of disinfectants in infection control. Dent Clin N Am 1991;35(2):323–337. PMID: 2032578.
23. Bharathi M, Vinod KKB. Disinfecting the impressions to prevent cross contamination: a review. J Res Adv Dent 2016;5(1):216–219. https://scholar.google.comscholar?hl=en&as_sdt= 0%2C5&q=Bharathi+M%2C+Vinod+KKB.+Disinfecting+the+impressions+to+prevent+cross+contamination%3A+a+review.+J+Res+Adv+Dent+2016%3B5%281%29%3A216%E2%80%93219.&btnG=.
24. Rosenstiel SF, Land MF. Contemporary fixed prosthodontics-e-book. Elsevier Health Sciences; 2015.
25. Bell J, Brockmann S, Feil P, et al. The effectiveness of two disinfectants on denture base acrylic resin with an organic load. J Prosthet Dent 1989;61(5):580–583. DOI: 10.1016/0022-3913(89)90280-1.
26. Garg N, Garg A. Textbook of operative dentistry. Boydell & Brewer Ltd; 2010.
27. Robinson DS, Bird DL. Essentials of dental assisting-E-Book. Elsevier Health Sciences; 2016.
28. Al-Jabrah O, Al-Shumailan Y, Al-Rashdan M. Antimicrobial effect of 4 disinfectants on alginate, polyether, and polyvinyl siloxane impression materials. Int J Prosthodont 2007;20(3):299. PMID: 17580464.
29. Peutzfeldt A, Asmussen E. Effect of disinfecting solutions on surface texture of alginate and elastomeric impressions. Scand J Dent Res 1990;98(1):74–81. DOI: 10.1111/j.1600-0722.1990.tb00943.x.
30. Yilmaz H, Aydin C, Gul B, et al. Effect of disinfection on the dimensional stability of polyether impression materials. J Prosthodont 2007;16(6):473–479. DOI: 10.1111/j.1532-849X.2007.00235.x.
31. Adabo GL, Zanarotti E, Fonseca RG, et al. Effect of disinfectant agents on dimensional stability of elastomeric impression materials. J Prosthet Dent 1999;81(5):621–624. DOI: 10.1016/s0022-3913(99)70219-2.
32. Al-Omari W, Jones J, Hart P. A microbiological investigation following the disinfection of alginate and addition cured silicone rubber impression materials. Eur J Prosthodont Restorative Dent 1998;6(3):97–101. PMID: 10218013.
33. Matyas J, Dao N, Caputo A, et al. Effects of disinfectants on dimensional accuracy of impression materials. J Prosthet Dent 1990;64(1):25–31. DOI: 10.1016/0022-3913(90)90148-6.
34. Taylor RL, Wright PS, Maryan C. Disinfection procedures: their effect on the dimensional accuracy and surface quality of irreversible hydrocolloid impression materials and gypsum casts. Dent Mater 2002;18(2):103–110. DOI: 10.1016/s0109-5641(01)00027-6.
35. Hardan L, Bourgi R, Cuevas-Suárez CE, et al. Disinfection procedures and their effect on the microorganism colonization of dental impression materials: a systematic review and meta-analysis of in vitro studies. Bioengineering (Basel) 2022;9(3):123. DOI: 10.3390/bioengineering9030123.
36. Sarangi D. Infection control in prosthodontics: a review. Indian J Forensic Med Toxicol 2020;14(4):8180. DOI: 10.37506/ijfmt.v14i4.12950.
37. Sumanth KS, Poovani S, Shetty S, et al. Infection control protocol in prosthodontics–a review. Int J Sci Res 2019;8(3):1–3. https://www.doi.org/10.36106/ijsr.
38. Stern MA, Johnson GH, Toolson LB. An evaluation of dental stones after repeated exposure to spray disinfectants. Part I: abrasion and compressive strength. J Prosthet Dent 1991;65(5):713–718. DOI: 10.1016/0022-3913(91)90211-e.
39. Mansfield SM, White JM. Antimicrobial effects from incorporation of disinfectants into gypsum casts. Int J Prosthodont 1991;4(2):180–185. PMID: 1781882.
40. Abdullah MA. Surface detail, compressive strength, and dimensional accuracy of gypsum casts after repeated immersion in hypochlorite solution. J Prosthet Dent 2006;95(6):462–468. DOI: 10.1016/j.prosdent.2006.03.019.
41. Vergani C, Ribeiro DG, Dovigo LN, et al. Microwave assisted disinfection method in dentistry. In: Chandra U, editor. Microwave heating [Internet]. London: IntechOpen. Available from: https://www.intechopen.com/chapters/17009 2011.
42. Malaviya N, Ginjupalli K, Kalahasthi D, et al. Sterilization of gypsum cast and dies by microwave irradiation: an in vitro study. Int J Contemp Med Res 2016;3(4):982–986. https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Sterilization+of+gypsum+cast+and+dies+by+microwave+irradiation%3A+an+in+vitro+study.+Int+J+Contemp+Med+Res+2016%3B3%284%29%3A982%E2%80%93986&btnG=.
43. McGowan M, Shimoda L, Woolsey G. Effects of sodium hypochlorite on denture base metals during immersion for short-term sterilization. J Prosthet Dent 1988;60(2):212–218. DOI: 10.1016/0022-3913(88)90318-6.
44. Brace ML, Plummer KD. Practical denture disinfection. J Prosthet Dent 1993;70(6):538–540. DOI: 10.1016/0022-3913(93)90268-s.
45. Da Silva FC, Kimpara ET, Mancini MNG, et al. Effectiveness of six different disinfectants on removing five microbial species and effects on the topographic characteristics of acrylic resin. J Prosthodont 2008;17(8):627–633. DOI: 10.1111/j.1532-849X.2008.00358.x.
46. Parker IV H, Johnson R. Effectiveness of ethylene oxide for sterilization of dental handpieces. J Dent 1995;23(2):113–115. DOI: 10.1016/0300-5712(95)98977-b.
47. Nagpal A, Chaudhary V. Infection control in prosthodontics. Indian J Dent Sci 2010;2(1):5–10. https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Nagpal+A%2C+Chaudhary+V.+Infection+

control+in+prosthodontics.+Indian+J+Dent+Sci+2010%3B2%281%29%3A5%E2%80%9310&btnG=.
48. Setz J, Heeg P. Disinfection of pumice. J Prosthet Dent 1996;76(4):448–450. DOI: 10.1016/s0022-3913(96)90553-3.
49. Infection control recommendations for the dental office and the dental laboratory. ADA Council on Scientific Affairs and ADA Council on Dental Practice. J Am Dent Assoc 1996;127(5):672–680. DOI: 10.14219/jada.archive.1996.0280.
50. Cuny EJ. Dental Infection Control and Technology. Inside Dent Assist 2010;6(6). https://www.aegisdentalnetwork.com/ida/2010/06/dental-infection-control-and-technology.
51. Assaf M, Mellor A, Qualtrough A. Cleaning endodontic files in a washer disinfector. Br Dent J 2008;204(10):E17–E17. DOI: 10.1038/sj.bdj.2008.411.
52. Whitworth C, Martin M, Gallagher M, et al. A comparison of decontamination methods used for dental burs. Br Dent J 2004;197(10):635–640. DOI: 10.1038/sj.bdj.4811832.
53. Srivastava A, Aaisa J, Kumar TA, et al. Alginates: a review of compositional aspects for dental applications. Trends Biomater Artif Organs 2012;26(1):31–36. DOI: 10.1351/PAC-REC-10-12-04.
54. Amalan A, Ginjupalli K, Upadhya N. Evaluation of properties of irreversible hydrocolloid impression materials mixed with disinfectant liquids. Dent Res J 2013;10(1):65. DOI: 10.4103/1735-3327.111795.
55. Wang J, Wan Q, Chao Y, et al. A self-disinfecting irreversible hydrocolloid impression material mixed with chlorhexidine solution. Angle Orthod 2007;77(5):894–900. DOI: 10.2319/070606-277.
56. Ginjupalli K, Alla RK, Tellapragada C, et al. Antimicrobial activity and properties of irreversible hydrocolloid impression materials incorporated with silver nanoparticles. J Prosthet Dent 2016;115(6):722–728. DOI: 10.1016/j.prosdent.2015.11.006.
57. Ginjupalli K, Shaw T, Tellapragada C, et al. Does the size matter? Evaluation of effect of incorporation of silver nanoparticles of varying particle size on the antimicrobial activity and properties of irreversible hydrocolloid impression material. Dent Mater 2018;34(7):e158–e165. DOI: 10.1016/j.dental.2018.03.016.
58. Ginjupalli K, Alla R, Shaw T, et al. Comparative evaluation of efficacy of Zinc oxide and Copper oxide nanoparticles as antimicrobial additives in alginate impression materials. Mater Today Proc 2018;5(8):16258–16266. DOI: 10.1016/j.matpr.2018.05.117.