ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 15, Issue, 07, pp.25417-25422, July, 2023
DOI: https://doi.org/10.24941/ijcr.45651.07.2023

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

STERILIZATION PROTOCOL IN ORTHODONTIC PRACTICE- A REVIEW

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ARTICLE INFO

Article History:
Received 10th April, 2023
Received in revised form
08th May, 2023
Accepted 20th June, 2023
Published online 30th July, 2023

Key words:
Sterilization, Disinfection, Historical background, Infection control, Orthodontic instruments.

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ABSTRACT

Sterilization in Orthodontics and particularly in the entire dental practice is an important topic which requires special attention because both the patients and the practitioners have a substantial risk of spreading infections like hepatitis B, pneumonia, tuberculosis and HIV. In depth knowledge of sterilization and disinfection is a key component of infection control. Control of infection that spreads through various instruments and armamentarium used in the field of orthodontics and also in the dental practice is of utmost importance to prevent cross- infection. As responsible clinicians, our goals should be to reduce the number of pathogenic organisms to a level at which our own body resistance may prevent infection and to break the circle of infection by eliminating cross-contamination. The present article reviews various recent methods of sterilization for an effective and efficient infection-free orthodontic practice.

Citation: ***Dr. Mahak Gagain, Dr. Prerna Hoogan Teja, Dr. Shruti Mittal and Dr. Gunjan Aneja.*** **2023.** "Sterilization Protocol in Orthodontic Practice- A Review*". International Journal of Current Research*, 15, (07), 25417-25422.

INTRODUCTION

The main purpose of infection control can be briefly summarized as blocking the transmission of microorganisms or pathogens. Blocking should be performed in two directions. The first is prevention of vertical transmission, and the other is prevention of horizontal or lateral transmission. Vertical transmission is the propagation of pathogens from generation to generation. Proper use and regulation of antibiotics is essential to prevent vertical transmission, requiring antibiotic stewardship. Lateral transmission is the transfer of resistance of a pathogen to other pathogens of the same generation, or propagation and expansion of the pathogen into its surroundings. Preventing this lateral transmission to the greatest extent possible is a practical point in terms of infection control. Methods to block lateral transmission include health care workers' hygiene management, with procedures such as hand hygiene, and infection control of the environment, involving procedures as cleaning and disinfection. Knowledge of disinfectionor antisepsis and sterilization is required for these measures. Doctors specializing in infection control who serve as medical directors have a solid knowledge of pathogens or antibiotics, butless knowledge of or interest in disinfection or sterilization[1].

DEFINITIONS[2]

Sterilisation: The term "sterilisation" refers to the process of eliminating all live germs, including bacterial spores. Physical, chemical, and physiochemical methods can all be used to sterilise anything. Chemisterilants are substances that are used to sterilise objects.

Disinfection: It is the process of getting rid of the majority of pathogenic germs on inanimate items, with the exception of bacterial spores. It is possible to disinfect via chemical or physical means. Disinfectants are substances that are utilised in cleaning.

Decontamination: It is the elimination of potentially harmful pathogenic bacteria from objects using a sterilisation or disinfection procedure.

Sanitization: It refers to the process of chemical or mechanical cleansing.

Asepsis: The use of methods (such as the wearing of gloves, the use of air filters, the use of UV rays, etc.) to create a microbe-free environment is known as asepsis.

Antisepsis: Using chemicals (antiseptics) to rid skin or mucous membranes of pathogenic bacteria is known as **antisepsis**.

Bacteriostasis: It is a state in which the bacteria are prevented from multiplying but are not killed.

Bactericidal: The substance that may eliminate or inactivate germs. Depending on their range of activity, these substances may go by several names, such as bactericidal, virucidal, fungicidal, microbicidal, sporicidal, tuberculocidal, or germicidal.

Antibiotics: These are compounds made by one type of bacterium that prevent or eradicate another germ. The phrase is frequently used

more broadly to refer to artificial and partially artificial antibacterial agents.

HISTORICAL BACKGROUND[3] (Fig 1)

- Medieval Era (5th to 15th Centuries)
- Early Modern Era (1500-1800)
- Progressive Era (1890S TO 1920S)
- Post World War II Era (1940S TO 1950S)

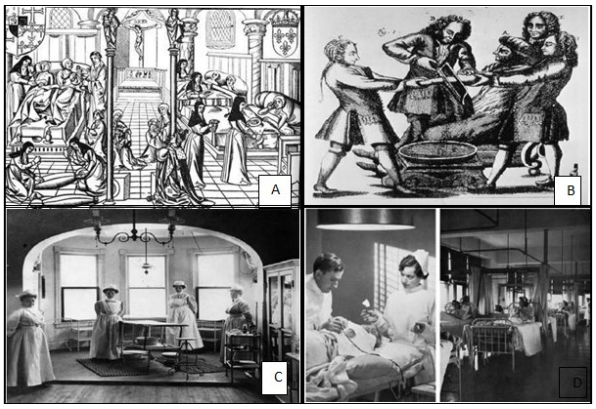


Fig. 1. Historical background from Medieval era to Post World war II era

A. Hôtel Dieu, Paris, circa 1500. The comparatively well patients (on the right) wereseparated from the very ill (on the left).
B. Amputation of arc
C. Clarkson Hospital operating room, Omaha, Nebraska, 1900.
D. TB hospital circa 1945. Pneumothorax operation (left) and 1940s TB ward (right).

ROUTES OF DISEASE TRANSMISSION IN DENTISTRY[4]

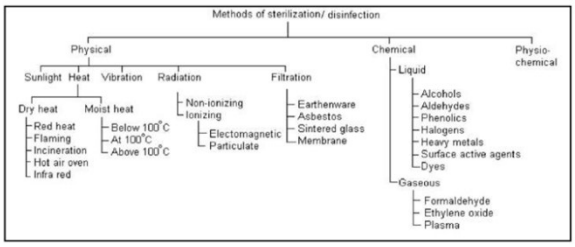
- Blood transfusion
- Sexual Transmission
- Getting pierced Tattooed with contaminated instruments
- Inadequate sterilization of medical equipment
- Unsafe injection
- Receiving contaminated blood products
- Child born to Hepatitis C positive mother

INFECTIOUS DISEASE COMMONLY ENCOUNTERED IN DENTISTRY[5]

Different hepatitis-causing viruses, HIV and AIDS, and tuberculosis (TB), particularly multidrug-resistant TB, are widespread infectious diseases that have an impact on the community's common conditions. Hepatitis A and E are spread through the fecal-oral route, whereas hepatitis B, C, D, and G follow a blood borne route of transmission. In less developedparts of the world, fecal-oral transmission of hepatitis A and E is linked to poor and unclean management of food and water contamination. HIV infection and tuberculosis, whether they occur separately or together, are prevalent diseases that affect some populations worldwide andeven in medically developed nations.

Methods Of Sterlization And Disinfection[6] (Table I)

Table I. Methods of sterilization and Disinfection



STEPS IN INFECTION CONTROL

Patient Screening: A consistent and thorough medical history of the patient can aid in identifying variables that support the diagnosis of systemic and oral illnesses. Patients frequently forget to provide the information. Every patient needs to be viewed as having a possible infection. This important fundamental application of infection control is termed as UNIVERSAL PRECAUTIONS.[7]

Personal protection: The orthodontist must defend himself from both external exposure and internal invasion ofthese diseases in order to resist the gamet of infectious organisms.

Immunological protection: The operator should get accessible vaccines that have been shown to be effective in preventing the start of clinical or sub-clinical infection for immunological protection.

Hepatitis B – If previously unvaccinated, give a 2-dose (Heplisav-B) or 3-dose (Engerix-B orRecombivax HB) series. Give intramuscularly (IM). For HCP who perform tasks that may involve exposure to blood or body fluids, obtain anti-HBs serologic testing 1–2 months after dose #2 (for Heplisav-B) or dose #3 (for Engerix-B or Recombivax HB). (0, 1 & 6)

Influenza – Give 1 dose of influenza vaccine annually. Inactivated injectable vaccine is given IM, except when using the intradermal influenza vaccine. Live attenuated influenza vaccine (LAIV) is given intranasally.
MMR – For healthcare personnel (HCP) born in 1957 or later without serologic evidence of immunity or prior vaccination, give 2 doses of MMR, 4 weeks apart.

Varicella (chickenpox) – For HCP who have no serologic proof of immunity, prior vaccination, or diagnosis or verification of a history of varicella or herpes zoster (shingles) by a healthcare provider, give 2 doses of varicella vaccine, 4 weeks apart.

Tetanus, diphtheria, pertussis – Give 1 dose of Tdp as soon as feasible to all HCP who have not received Tdp previously and to pregnant HCP with each pregnancy. Give Td boosters every 10 years thereafter. Give IM

Meningococcal – Give both Men ACWY and MenB to microbiologists who are routinely exposed to isolates of Neisseria meningitidis. Every 5 years boost with MenACWY if risk continues. Give MenACWY and MenB IM.

- Barrier protection
- Sterilization and Disinfection of orthodontic Instruments and Materials Basicrequirements.[8]

SPAULDING SYSTEM FOR ORTHODONTIC INSTRUMENTS

Orthodontic instruments can be of three categories according to Earle H Spaulding.

- **Critical:** - Instruments that penetrate the mucosa must be sterilized. E.g. Bands, band removers, orthodontic mini-implants, orthodontic mini-implant placement kit etc.
- **Semi Critical:** - Instruments that touches the mucosa should be sterilized whenever possible or treated with high level disinfectants. E.g. most of the orthodontic instruments, mirrors, retractors, dental hand pieces, etc.
- **Least Critical:** - Instruments that don't touch mucous membrane such as heavy wire cutter, ligature cutter, arch forming pliers, torquing keys, bracket positioning gauges, V-bend forming plier etc. should be disinfected.[9]

Instrument Processing[10]

a) Holding (presoaking)
b) Precleaning

c) Corrosion control and lubrication
d) Packaging
e) Types of Sterilization
f) Sterilization for orthodontic armamentarium
g) Monitoring sterilization
h) Storage
i) Waste and sharp disposable systems

- **Presoaking**: Placing instruments in presoak solution until time for full cleaning is available inhibits drying, begins to breakdown organic material, and, in some cases, begins microbial death. Presoak solution is made up of detergents, enzymes, or detergents with disinfectants.
- **Cleaning:** Blood, saliva, and tool materials can protect underlying germs from sterilising agents. Cleaning helps to lessen the bioburden.
- **Corrosion**: It is an electrolytic process in which the interaction of two different metals or dissimilar locations within a single metal creates a potential difference, resulting in the flow of electrons. The electron flow produces reactive ions, which rapidly react with ambient oxygen to generate oxides (rust). Extreme temperatures, physical abrasion, galvanism, or reactive extraneous ions that damage the chromium oxide layer will make the steel corrosive. Carbon or 400 series steel instruments are more vulnerable than 300 series steel instruments..
- **Packaging**: To prevent recontamination after sterilisation, cleaned instruments should be packed prior to sterilisation. Before sterilisation, the equipment should be packaged in an appropriate wrapping material. The steriliser should be wrapped in a material specified for a certain type of steriliser. For example, a single layer cloth wrap for steam sterilisation, self-sealing polyfilm paper pouches for chemical vapour sterilisation, and paper wrap for dry heat sterilisation are all examples..

Types of Sterilization

HOT AIR OVEN: Dry heat denatures microbe protein, rendering it nonviable. It runs for 1-2 hours at a temperature of 1600 C. Smaller dental units rely on convection ratherthan forced air circulation. Larger capacity units are either convection or forced air circulation devices. The sterilisation process begins only after the required temperature of 160°C is reached and sustained.

RAPID HEAT STERLIZER: At 375°F, a controlled internal air flow mechanism is used. Unwrapped instruments are sterilised in 6 minutes and wrapped devices in 12 minutes.

AUTOCLAVE: Moist heat denatures and coagulates microorganism protein. The sterilisation is caused by the latent heat of vaporisation that exists in damp heat. Whensteam condenses on cooler surfaces, it turns into water and transfers latent heat to thatsurface. In autoclaves, this principle is applied. The needed temperature is 121°C for 20 minutes at 15 pounds of pressure.

STERILIZATION FOR ORTHODONTIC ARMEMTARIUM

Disinfection of orthodontic brackets: Reusing orthodontic brackets is not recommended since it compromises clinical performance and raises the risk of infection. Speera *et al*. conducted a study to investigate the effect of 0.01% chlorhexidine disinfection solution on bond strength of metal and ceramic brackets and concluded that chlorhexidine has no significant effecton the adhesion ability of metal and ceramic brackets. As a result, chlorhexidine is thedisinfection of choice for metal and ceramic brackets.

Disinfection of orthodontic bands: During fixed orthodontic treatment, stainless steel bands are most typically utilised on molars. Glass bead sterilisation has been demonstrated to be as effective as autoclave sterilisation. The suggested sterilisation process for single molar bands is 220°C for 5 seconds. When more than one band is put at the same time, the time required doubles. Other disinfection methods, such as a 5-second tap water rinse, a 10-second soap scrub,a 30-minute soak in alcohol, and an alcohol flame, were ineffective in eliminating bacteria or spores. However, alcohol flames were helpful in inhibiting development on staphylococcus albus-inoculated orthodontic molar bands.

Disinfection of orthodontic pliers: The physical and mechanical qualities of orthodontic pliers have been observed to be affected by sterilization techniques, and there is a considerable danger of corrosion. Autoclaving harms orthodontic equipment by blunting and corroding their sharpcutting edges. One of its biggest drawbacks is that it takes time. As an alternative, soaking in 1% sodium nitrate can be considered. Pliers made of stainless steel can be sterilized efficiently using steam sterilization because it has no negative side effects. When comparing autoclaving to cold disinfection, Jones discovered no significant difference in the look, corrosion, or efficiency of orthodontic pliers. Chrome-plated pliers appear to be more resistant to damage than stainless steel pliers. Other approaches include a 10-second microwave irradiation, glass bead sterilization for 30 seconds are recommended.

Disinfection of elastomeric chains: Polyurethane elastomers are often utilised as ligatures and chains in orthodontics. Because elastomeric ligatures are not heat resistant, they are routinely sterilised using cold sterilisation. It is recommended that these materials be disinfected in a 5% glutaraldehyde solution for 10 minutes.

Ligatures: Metal and elastomeric ligatures have the potential to be agents of infectious disease transmission. Cross-contamination in the orthodontic clinic is a severe concern,because cold sterilisation might damage the elastomeric material.

Sterilization of orthodontic archwire

Alavi *et al*. investigated the effect of steam and dry heat sterilisation on the bending properties of Ni-Ti arch wires and discovered substantial differences in the bending properties of super elastic Ni-Ti arch wires. These wires demonstrated decreased superelasticity and applied force in both loading and unloading forces.

Sterilization of orthodontic mini-implant: For mini-implants, a single cycle of autoclave sterilisation is advised. Since then, it hasbeen demonstrated that repeated sterilisation has a detrimental effect on its primary stability.

Disinfection of removable appliances: Disinfection of detachable orthodontic appliance baseplates with 0.12% chlorhexidinespray once or twice a week minimises Streptococcus Mutans contamination on the acrylic surface.

Rubber items and saliva ejectors: The best option is to throw them away after each use. Rubber materials are useless for ethylene oxide sterilisation, and they may be harmed by dry or moist heat sterilisation.

Hand pieces: Hand parts can be sterilised using steam, dry heat, chemical vapour, or ethylene oxide.Instruments that rotate Burs become extremely contaminated and are classified as critical objects; following usage, they must be sterilised. Diamond and carbide burs can be autoclaved safely with little damage, whereas carbon-steel burs areharmed by autoclaving. A chemical vapour steriliser can be used to sterilise carbon-steelburs. During the same dental treatment, a glass bead steriliser at 218oC for 10 seconds can be used to sterilise highly contaminated carbon-steel burs.

Visible-light curing units: Light curing devices have been shown to be a potential source of infectious disease transmission due to contamination of the light curing tip, which directly contacts oral structures, and the handle, which becomes contaminated with blood and saliva from the operator's or assistant's gloved hands. Some newer models have replaceable, autoclavable light curing tips.

Fig.2. Segregation of Biomedical and Non-Biomedical waste

Table II. The Rationale of PPEs for Orthodontic and Dental Setup

Setting	Activity	Risk	Recommended PPE	Remarks
Triage	Triaging patients Provide a triple-layer mask to the patient	Moderate risk	N95 mask Gloves	Patients get masked
Screening area help desk/ registration counter	Provide information to patients	Moderate risk	N95 mask Gloves	
Temperature recording station	Record temperature with the handheld thermal recorder	Moderate risk	N95 mask Gloves	
Waiting area	Nurses/paramedic interacting with patients	Moderate risk	N95 mask Gloves	A minimum distance of 1 m needs to be maintained
Orthodontist/dentist chamber	Clinical management (doctors, nurses)	Moderate risk	N95 mask Gloves	No aerosol-generating procedures should be allowed
Sanitary staff	Cleaning frequently touched surfaces/floor/ cleaning linen	Moderate risk	N95 mask Gloves	
Visitors accompanying young children and elderlies	Support in navigating various service areas	Low risk	Triple-layer medical mask	No other visitors should be allowed to accompany patients in OPD settings. The visitors thus allowed should practice hand hygiene

However, the handles remain a problem because they cannot be sterilised. After use, units should be cleaned and disinfected using a phenolic disinfectant.

Stones: Dry heat, chemical vapour, and ethylene oxide gas sterilisation are preferred methods for diamond stones. Chemical vapour and ethylene oxide sterilisation are preferred for polishing stones. Polishing buffs are sterilised by immersing them for 30 minutes in CIDEX (2% glutaraldehyde) solution or 5% Bibforte solution.

Impression trays. Dry heat is not ideal for aluminium trays. All sterilisation procedures can be used on chrome-plated trays. Ethylene oxide or glutaraldehyde sterilisation is preferred for plastic or acrylic trays.

Orthodontic Marking Pencils. Autoclavable orthodontic marking pencils are not available. Gas sterilisation, as employed in this study, is effective in killing bacteria but is also expensive and complex to implement, making it unsuitable for orthodontic offices.

Orthodontic adhesives include: A polymeric matrix in composites used as orthodontic direct bonding adhesives can host and foster a range of aerobic and anaerobic bacteria operating alone or in combination. Their accumulation might weaken the connection and even cause the tooth to attack.

Monitoring sterilization: Monitoring the effectiveness of the sterilization process in a particular time interval is very important. Spores of Bacillus stearothermophilus are used to monitor steam and unsaturated chemical vapor sterilizers, and spores of Bacillus subtilis are used to monitor dry heat sterilizers. In spore testing the biological indicators (spore strips or vials) are kept inside a regular instrument package.

Storage of sterilized instruments: Unpackaged sterilised instruments have a zero-sterile shelf life after being taken fromthe steriliser. Allow packages not to be compressed. Keep the packaging in a dust-free environment. The sterile shelf life is determined by the packaging material's integrity.This is determined by ensuring that the package is never moist, by inspecting the packaging for tears when it is withdrawn from storage, and when it is delivered to the chair side for use on the next patient.

Waste and Sharps disposable system[11] (Fig 2): In Dental HealthCare Facilities, Regulated Medical Waste is managed by using a color-coded or labelled container that inhibits leakage (e.g., biohazard bag) to contain non- sharp regulated medical waste. Handling, segregation, mutilation, disinfection, storage, transportation, and final disposal are all critical procedures in the safe and scientific management of biomedical waste in any setting.

DENTAL UNIT WATER SYSTEM CONTAMINATION CONTROL[12]

There are numerous solutions for preventing dental treatment water system contamination. Thefirst step is to adapt the dental unit with a self-contained reservoir (bottle system). Some periodic cleaning agent makers believe that periodic cleaning is adequate for controlling treatment water pollution, however experimentation and science have demonstrated otherwise. If municipal water is utilised as an irrigant, the quality of the water varies from 10 cfu/mL to several thousand cfu/mL at the same area, making it unsuitable for treatment, l*et al*one swimming. Water that has been treated with a physical or chemical approach, or a low-grade antibacterial, must therefore be utilised. Dental units with low grade antibacterial irrigant should be used on a regular basis to replenish the lines with new fluid; otherwise, the active ingredient used to control the germs in the lines depletes. For example, the same antimicrobial irrigant may provide superior microbial control in dental units that see at least 5 patients per day (as in private dental clinics) than in units that see about 2 patients per day (as in a dentistryschool context).

MANAGEMENT OF EXPOSURE TO BLOOD AND BODY FLUIDS

Steps to be taken in the event of an exposure

If it was a splash or spatter exposure to the mucosa—

Wash the area with flowing water/eyewash station for at least 10 minutes

- Contact a medical practitioner/infectious diseases specialist who can evaluate thesituation.
- Initiate treatment of the exposed personnel as needed with antibiotics and antiretroviral medications and future follow-up of the source and the exposed
- If it was a sharps injury (needle-stick, puncture wound from a contaminatedinstrument—
- Wash the injured area with an antimicrobial soap for about 2-3 minutes
- Apply first aid (medications / band-aid / suture) as needed
- Contact a medical practitioner/infectious diseases specialist who can evaluate thesituation.
- Initiate treatment of the exposed personnel as needed with antibiotics and antiretroviral medications and future follow-up of the source and the exposed.

CURRENT COVID GUIDELINES IN STERILIZATION[13]

The COVID-19 epidemic has altered the practise of orthodontics. Strict infection control, near- zero aerosol output, and limited contact dentistry are essential for preventing orthodonticoperatory contamination. Only emergency orthodontic procedures could be provided toorthodontic patients during the pandemic while keeping to all regulatory criteria. (Table II)

CURRENT GUIDELINES FOR MONKEYPOX VIRUS[14]

Infection prevention and control measures

Standard infection prevention and control (IPC) procedures, such as the use of gloves, aprons, fluid-resistant surgical masks (FRSM), and eye protection, as suggested in the National IPC manual for England, would give protection from contact transmission. There isn't enough data yet to confirm or deny aerial transmission as a key mode of communication. However, given the documented occurrence of droplet transfer, AGPs such as the use of high-speed handpieces and ultrasonic instruments provide a heightened risk of transmission. The standard IPCprecautions of an FRSM and eye protection during AGPs would be less than the necessary degree of protection for doing an AGP on a monkeypox patient.. Instead, respiratory protectionwould be necessary, such as a filtering face piece 3 (FFP3) mask, fluid-resistant gown, and visor. It should be highlighted that in areas where community predominance is low, this scenario is unlikely.

Vaccination

MPXV has become the most important member of the Orthopoxvirus genus in terms of relevance to human health and disease since the elimination of smallpox in 1980 through widespread immunisation. Because the two viruses are so similar, smallpox vaccinationprovides some protection against monkeypox. However, the discontinuation of smallpox immunisation since the disease's eradication is likely to have lowered population immunity to Orthopox viruses like MPXV. In the United States, a third-generation smallpox vaccine (Modified Vaccinia Ankara - Bavarian Nordic [MVA-BN]), which uses an attenuated vaccinia- virus, is marketed under the brand name JYNNEOS and is authorised for the prevention of smallpox and monkeypox. The The same vaccine, marketed as Imvanex, is authorised in the UK for smallpox protection; however, use of the MVA-BN vaccine for monkeypox preventionin the UK is an off label use.43 Vaccination is currently being examined in the UK for pre-exposure prophylaxis in high-risk groups, as well as for healthcare and laboratory personnel who may be exposed to monkeypox patients or work with MPXV samples. The vaccine is given as post-exposure prophylaxis to confirmed cases' contacts.

GUIDELINES FOR EBOLA VIRUS[15]

Prevention of Ebola infection

- Take a medical history, including a travel history from their patients with symptomsfor which a viral infection is suspected
- Any person within 21 days of returning from an Ebola affected country may be at riskof having contacted persons infected with Ebola and may not exhibit symptoms
- If there is a disclosed risk, consider delaying routine dental care for the patient until 21 days have elapsed from the time of their departure from the affected region.
- Palliative care for serious oral health conditions, dental infections and pain can be provided if necessary, after consulting with the patient’s physician and conforming to

standard infection control precautions, including PPE for droplet precautions and physical barriers.

CONCLUSION

"Prevention is better than cure," a maxim that applies perfectly to sterilisation. A thorough understanding of the application of sterilisation will aid in ensuring safety from microbiological diseases. A thorough understanding of sterilisation applications will aid in ensuring protection from the invisible but lethal world of microbiological diseases. The use of correct sterilisation, disinfectants, and aseptic procedures assists us in meeting our professional criteria for safety.[16] To offer a safe environment for themselves, their patients (including patient family members), and the entire orthodontic team, orthodontists must be especially aware of the available evidence.[7]

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