



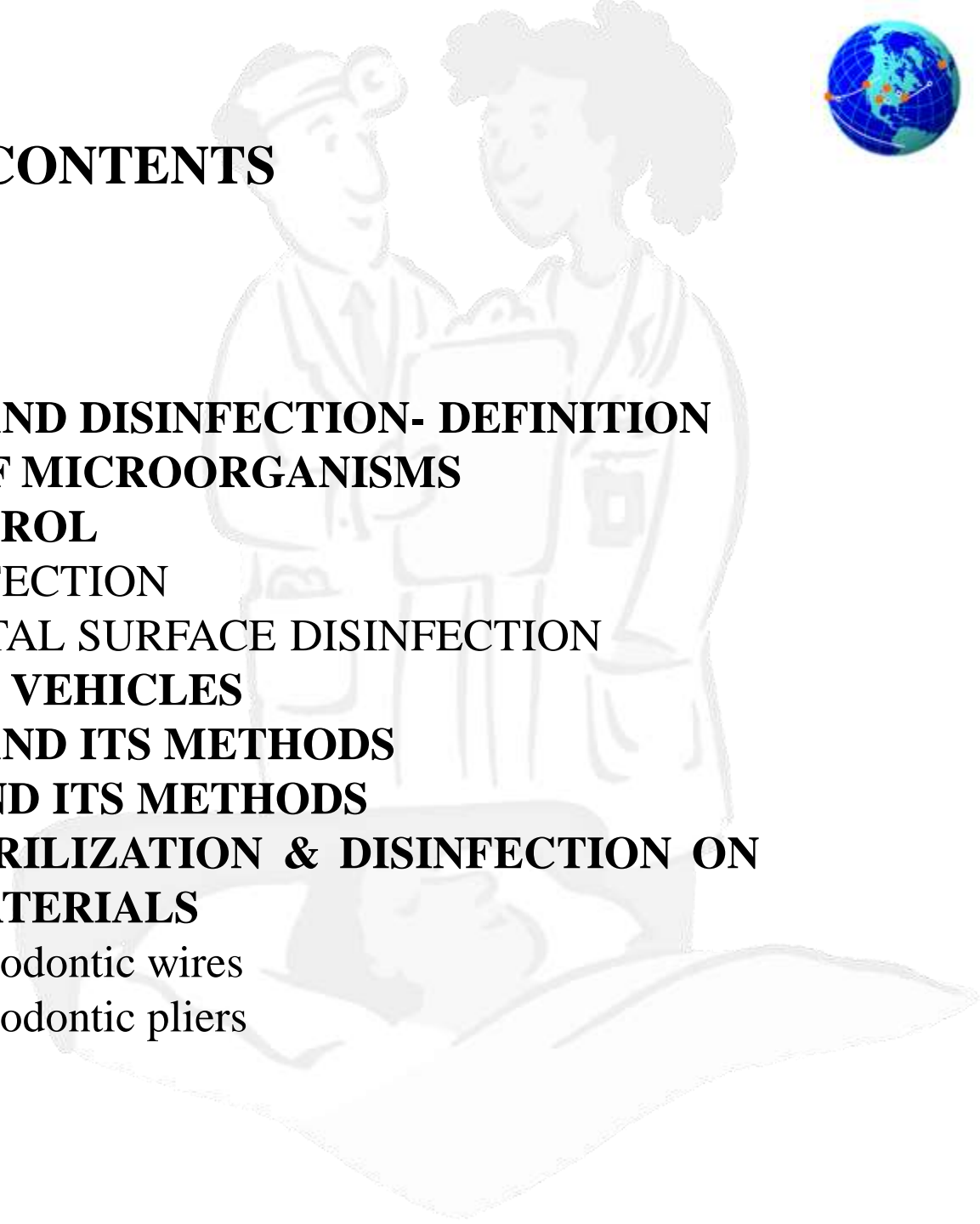
# **STERILIZATION & DISINFECTION OF ORTHODONTIC INSTRUMENTS AND CONSUMABLES**





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## INTRODUCTION

For protection of both the doctor and patient, sterilization techniques are of utmost importance in preventing the spread of infectious disease. This is of special significance in dentistry because more microorganisms are found in the oral cavity than in any other part of the body. With the increasing number of adult patients and diverse life-styles, the orthodontist is more at risk than ever to exposure to serious pathogens and must take precautions to guard against their transfer.

Orthodontists have the second highest incidence of hepatitis B among dental professionals **(Starnbach, 1980)**. Saliva is about half as infectious as blood, and the most likely modes of transmission in dental offices are through puncture wounds, skin abrasions, or lesions.



Dental aerosols, splattering, and instrument contamination can also transmit the virus, which can survive for several weeks at room temperature.

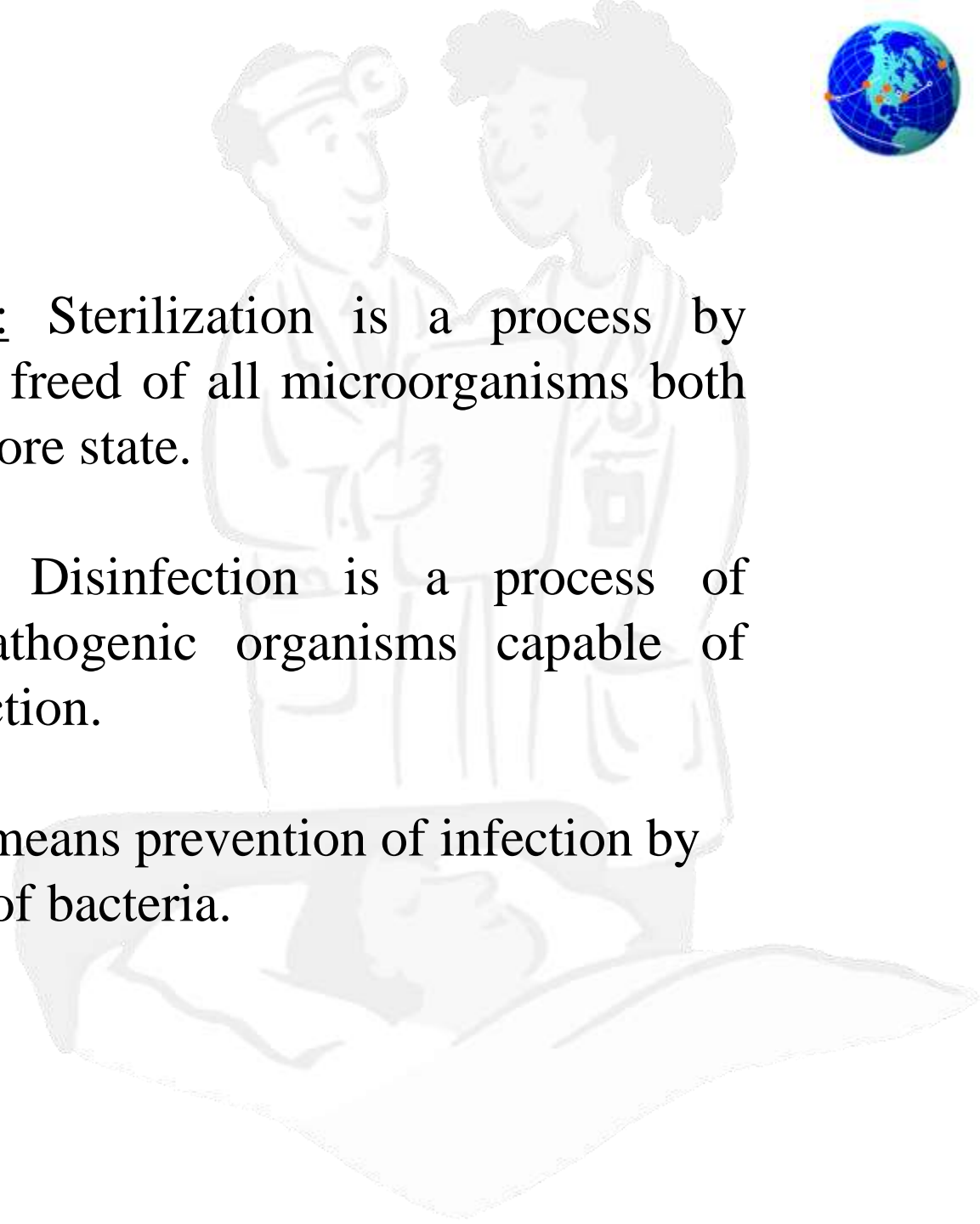
Hepatitis B (serum hepatitis), herpes, and AIDS viruses are certainly the more serious diseases of many that can be contracted in an orthodontic office. The HTLV-III (AIDS) virus is more fragile and less infective; transmission is most likely to occur after repeated blood-to-blood or blood-to-mucosa contact or sharing of hypodermic needles. Still, the increasing incidence of AIDS, as well as of hepatitis B, has made orthodontists even more aware of the necessity of decontaminating instruments and surfaces.



**STERILIZATION:** Sterilization is a process by which articles are freed of all microorganisms both in vegetative or spore state.

**DISINFECTION:** Disinfection is a process of destruction of pathogenic organisms capable of giving rise to infection.

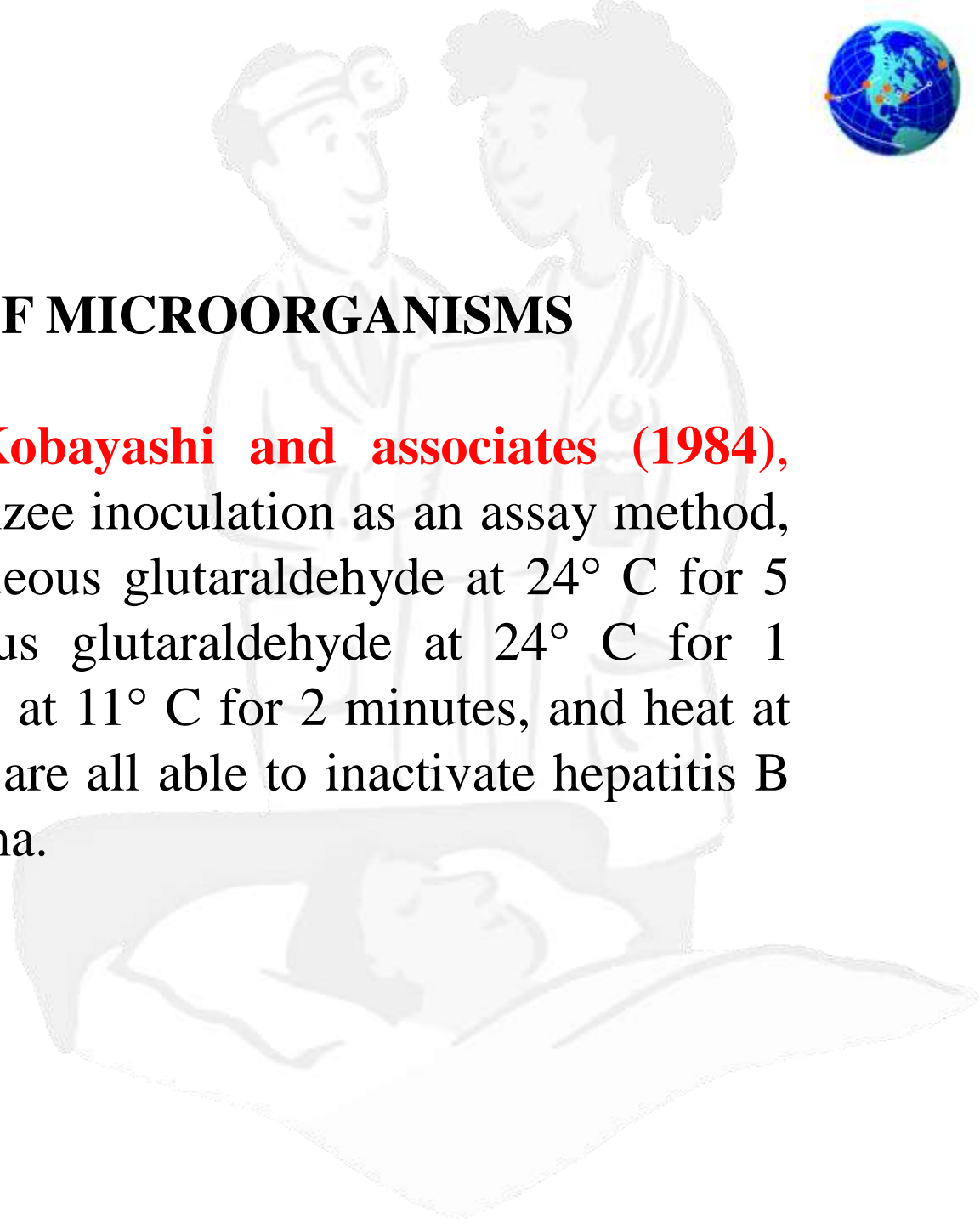
**ANTISEPTIC:** It means prevention of infection by inhibiting growth of bacteria.





## INACTIVATION OF MICROORGANISMS

Hepatitis virus → **Kobayashi and associates (1984)**, using direct chimpanzee inoculation as an assay method, found that 0.1% aqueous glutaraldehyde at 24° C for 5 minutes, 1% aqueous glutaraldehyde at 24° C for 1 minute, 80% ethanol at 11° C for 2 minutes, and heat at 98° C for 2 minutes are all able to inactivate hepatitis B virus in human plasma.





AIDS virus→ AIDS virus is inactivated after treatment with 50% ethyl alcohol, 35% isopropyl alcohol, 0.1% household bleach, Lysol, and 0.3% H<sub>2</sub>O<sub>2</sub> at room temperature (21° to 25° C) for 2 to 10 minutes. Heating at 56° C for 30 minutes inactivates the AIDS virus, and one investigator found the virus titer level dropped to undetectable levels after 10 minutes of heating at 56° C in the presence of serum. HTLV III/LAV has unusual stability at room temperature. Infective viral particles have survived for more than a week at 20° to 22° C in either dry form or liquid medium.



# INFECTION CONTROL

An infection-control program comprises two distinct areas,

- 1) Exposure control and
- 2) Hazard communication

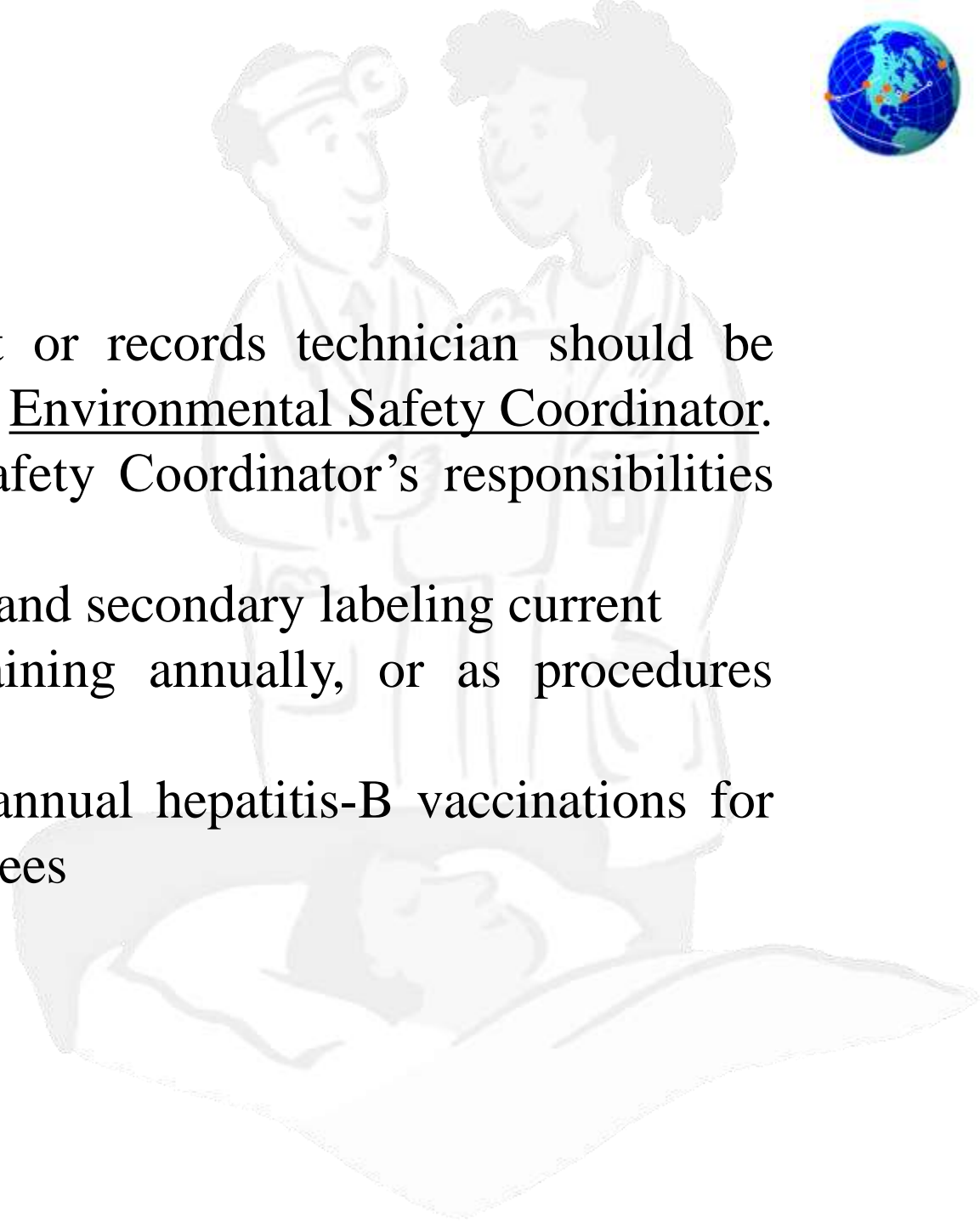
Exposure control covers sterilization and disinfection, waste management, and employee safety and education, including personal protective equipment and bodily-fluid-exposure protocols.

Hazard communication requirements include drills for hazard communication plans (chemical spills, emergency first aid, and fire or tornado evacuation), secondary labeling of hazardous chemicals, Material Safety Data Sheets, x-ray updates, and properly displayed state and federal posters.



A chair side assistant or records technician should be appointed as the office Environmental Safety Coordinator. The Environmental Safety Coordinator's responsibilities include:

- Keeping all manuals and secondary labeling current
- Conducting staff training annually, or as procedures change
- Keeping records of annual hepatitis-B vaccinations for patient-contact employees





- Conducting and documenting weekly spore tests or other appropriate monitoring of sterilization equipment
- Maintaining infection-control inventory
- Cleaning equipment nightly, weekly, or monthly as required
- Filing exposure-incident reports

The main tasks of infection control are implementation of barriers to the spread of pathogens, disinfection of environmental surfaces, and sterilization



## Barrier Protection



Long-sleeved, jewel-neck clinic jackets should be worn in the laboratory and operator. These jackets should be replaced daily, or when visibly soiled, and worn only in the office.



Masks and protective eyewear are required during bonding and debonding procedures to protect against aerosols of blood and saliva. Face shields or side shields should be added to personal eyeglasses. Masks and face shields are required whenever a handpiece is used.



Patients should be provided eyewear during any procedure with a risk of eye injury from debris or chemical agents.

Latex gloves must be worn for all patient procedures, and changed between patients. Gloves must also be removed and replaced before handling materials such as charts, study casts, and radiographs.



## Environmental Surface Disinfection



In the operatory, use a spray-wipe-spray technique with a phenol solution that cleans, disinfects, and deodorizes. After each patient, any exposed surfaces—chairside units, pencils, pens, counters, chairs—are sprayed with phenol and wiped down with a paper towel. This reduces the number of microbes that must be killed and removes any bodily fluids that may insulate the remaining microbes.

The surfaces are then resprayed and allowed to dry for 10 minutes, after which excess moisture is wiped away. Dental chairs only have to be sprayed after handpiece procedures that can create aerosols.



Clear plastic wrap should be used over the handpiece consoles and over all chairside switches or handles.

In the laboratory, alginate impressions are rinsed with water after removal from the patient's mouth, sprayed with Biocide, and placed in reclosable sandwich bags. (Phenols such as Birex should not be used because they can distort impressions).

The impressions are rinsed again with water and dried before pouring, and they are always handled with latex gloves. Finished appliances are placed in sandwich bags or retainer boxes until delivery.



# CONTAMINATION VEHICLES



- Payne in AJO 1986** explained the three possible pathways of cross-contamination and its handling methods as
- 1) Critical— Instruments that penetrate the mucosa must be sterilized.
  - 2) Semicritical— Instruments that touch the mucosa should be sterilized.
  - 3) Least critical— Surfaces touched during treatment should be disinfected.

Using this as a guide, scalers, scalpels, and other tissue-cutting instruments must be sterilized. Other hand instruments and pliers should be sterilized. Work surfaces, triplex syringe handles, operating light handles, and other environmental surfaces should be disinfected.



**Shanon T. Kirchhof in JCO 1987** pointed out that to prevent the spread of infection in an orthodontic office, there are three main contamination vehicles that must be effectively sterilized,

- 1) Instruments contaminated with blood or saliva
- 2) Surfaces contaminated with blood or saliva, and
- 3) Staff members' hands

### **Instruments**

Instruments requiring sterilization include mirrors, pliers, scalers, banding and bonding instruments, bands, impression trays, cotton pliers, and ligature directors. Some, including plastic band seating instruments, cheek retractors, mirrors, and bite planes, cannot withstand heat sterilization.



If ethylene oxide is not being used and the instrument would be damaged by heat sterilization, it should be thoroughly debrided and submerged in a fresh solution of glutaraldehyde or formaldehyde for one to 10 hours. The length of time depends on the sterilant used and the temperature of the solution.

## **Surfaces**

Surfaces that cannot be sterilized should be effectively disinfected. These surfaces include bracket trays, air/water syringes, saliva ejector handles, chair control buttons, operatory light handles, sink handles, supply drawers, and chair armrests and headrests. Each office can prepare its own list of operatory surfaces.



Proper office and equipment design will reduce the number of surfaces that need disinfecting. Foot-activated chair controls and foot- or knee-operated sinks and soap dispensers are a few ways to avoid hand contact.

Contaminated surfaces can be scrubbed with iodophor-soaked 4" × 4" gauze pads and allowed to dry. Gauze soaked with 70 percent alcohol can be used to remove the residue after drying. The iodine solution has a built-in antimicrobial activity indicator— when it turns from amber to clear, it should be replaced. Iodophors have a slight allergenic reaction with skin and can stain light-colored surfaces after repeated use.



The recently introduced **Vitawipes** are disposable disinfectant cloths containing polyhydrochloride (3.2 percent), alkyl dimethyl, benzyl ammonium chloride (7.1 percent), and inert ingredients (89.7 percent). A cloth is dampened with water and used to wipe contaminated surfaces. It does not kill bacterial spores, mycobacterium tuberculosis, or hepatitis B virus on contact, but disinfects by physically removing the potential pathogens. The cloth is disposed of after an indicator strip changes color or after wiping a surface contaminated with hepatitis B virus. The wipes are easy to use and show minimal reaction with skin, but they have not been fully tested.



## Hands



Hands are the most common link in the contamination chain. Proper handwashing reduces the number of potential pathogens, but it does not sterilize the skin. The hands, fingers, and fingernail bed have breaks in the epidermis that cannot be seen with the naked eye.

Patients' blood has been retained under the fingernails of unprotected hands for five or more days after patient contact.

Hands should be washed for 20 seconds with an effective antimicrobial soap. The soap should have residual action because of the warm, moist environment created by gloves.



Gloves provide the necessary physical barrier from pathogenic organisms and should be worn while treating all patients. The smooth surface of gloves also allows more effective handwashing between patients.

Gloves must fit properly to prevent loss of dexterity. Hand cream can be applied before glove use if one is sensitive to talc or cornstarch.

Masks and eye protection are recommended to protect from aerosols and particle debris produced by handpieces, air/water syringes, trimming and polishing burs, and other equipment.



**Fernando Ascencio in JCO 1998** studied whether orthodontic marking pencils can pick up and transfer bacteria from patient to patient during typical orthodontic procedures. The results showed that marking pencils can transfer bacteria from contaminated archwires.

He concluded that conventional orthodontic marking pencils cannot be autoclaved. Gas sterilization is effective in killing bacteria, but is also costly and difficult, making it impractical for orthodontic offices.



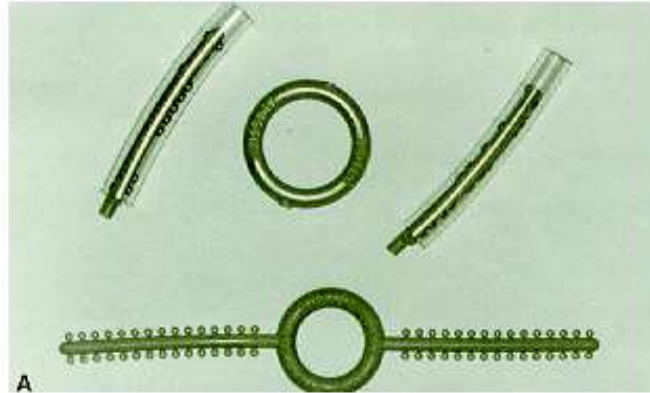
Soaking or spraying the tips of marking pencils with disinfectants could be more effective than wiping, but this method is unlikely to gain acceptance from practitioners. The only sure way to avoid potential cross - contamination is to use the inexpensive disposable markers available from orthodontic supply companies.

Metal and elastomeric ligatures are potential agents in the transmission of infectious diseases. **Mulick (1986)** recommended single-use dispensing of elastomeric materials to eliminate contact of canes or sticks with contaminated hands.



## Schneeweiss in JCO 1993

described a method of cutting elastomeric modules into smaller sections and covering them with clear tubing, which could then be cold sterilized.



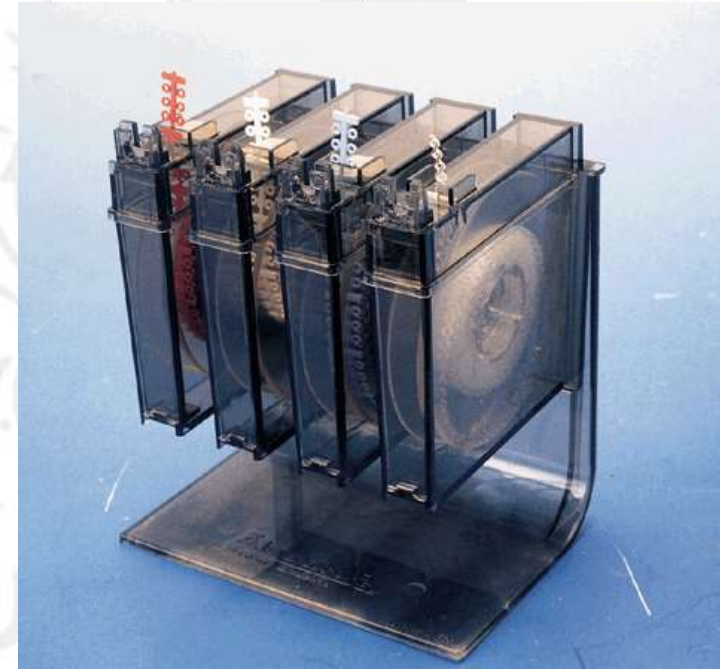
During archwire placement, the operator contacts only the outside tubing while removing ligatures

More recently, dispensers have been introduced onto the market, but the effectiveness of such dispensers in controlling cross -infection has yet to be fully evaluated.



**Takla in JCO 1998** evaluated the effectiveness of a new elastomeric module dispenser in reducing bacterial contamination, as compared with the existing method of storing and dispensing elastomeric modules on canes.

He concluded that the Alastik elastomeric module dispenser proved to be efficient in limiting cross-infection through single-use dispensing, although it did not offer protection against handling and environmental factors, such as dust



Alastik elastomeric module dispenser



# STERILIZATION AND ITS METHODS



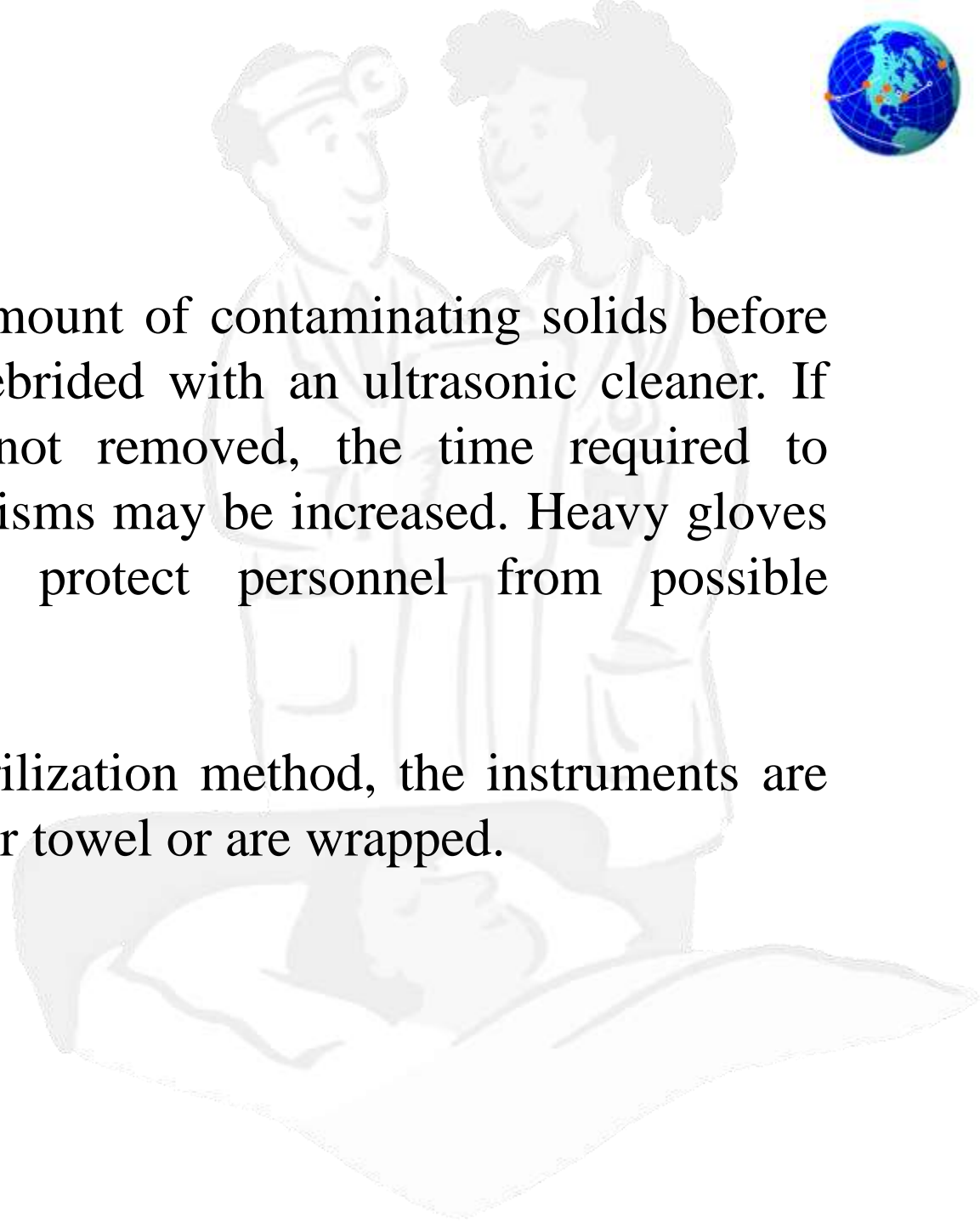
Sterilization destroys all microorganisms, including viruses and spore forms, and usually involves the use of heat. To sterilize properly and avoid damaging instruments, specific steps must be followed.

After each patient procedure, sharps are discarded in a sharps container, and disposable items in a recessed, plastic-lined wastebasket. Plastic items that cannot be autoclaved are placed overnight in Procide, an immersion sterilization solution. Heat-sterilizable cheek retractors are also immersed in Procide, since they tend to turn milky after autoclaving. Handpieces and photographic mirrors are sterilized in a Kavo-Klave.



Rinsing reduces the amount of contaminating solids before the instruments are debrided with an ultrasonic cleaner. If infected material is not removed, the time required to destroy all microorganisms may be increased. Heavy gloves should be worn to protect personnel from possible contamination.

Depending on the sterilization method, the instruments are then placed on a rack or towel or are wrapped.





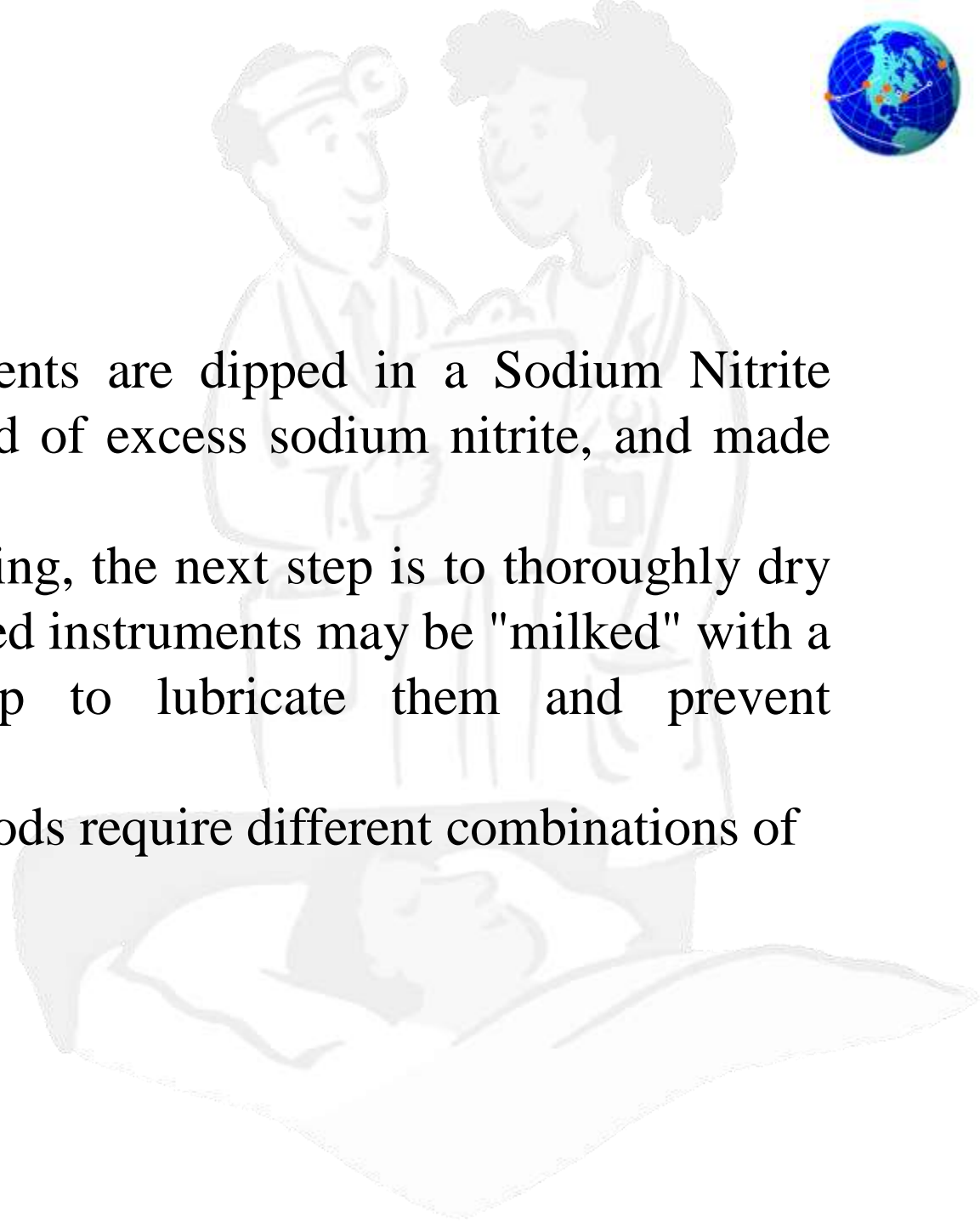
Plier racks and instruments are placed in a wire basket and run through an ultrasonic cleaner containing a rust-inhibiting Non-Ionic Multipurpose Ultra-sonic Cleaner. Ultrasonic solutions should be changed daily and covered during cleaning to reduce aerosols. Instruments and pliers should not be rinsed after ultrasonic cleaning. Any dried blood that remains must be scrubbed off by hand, and the ultrasonic cleaning must then be repeated before sterilization.



Alternatively instruments are dipped in a Sodium Nitrite Rust Inhibitor, drained of excess sodium nitrite, and made ready for sterilization.

After ultrasonic cleaning, the next step is to thoroughly dry the instruments. Hinged instruments may be "milked" with a water-soluble oil dip to lubricate them and prevent corrosion.

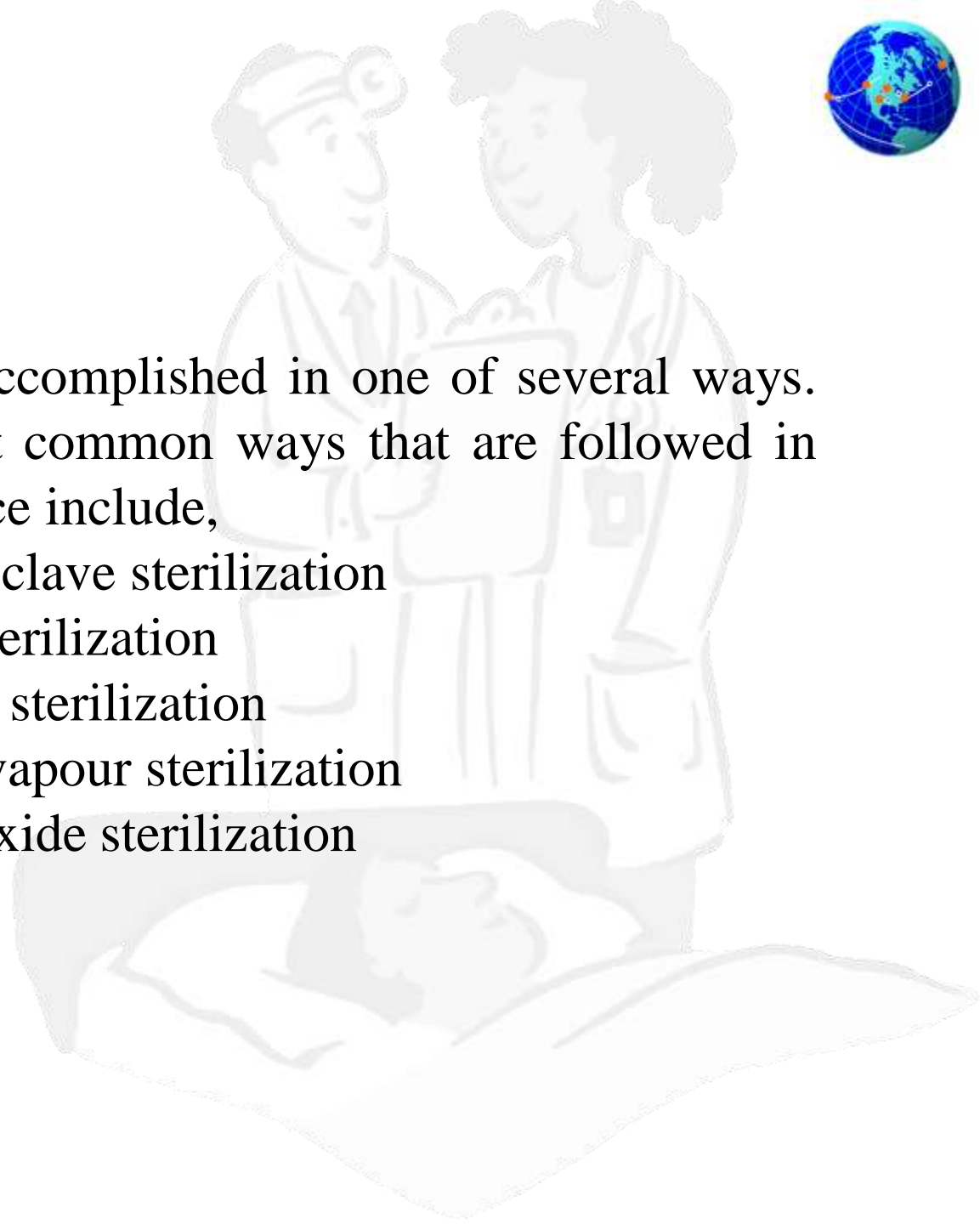
The sterilization methods require different combinations of time and temperature.





Sterilization can be accomplished in one of several ways. Some of the most common ways that are followed in orthodontic practice include,

- 1) Steam autoclave sterilization
- 2) Dry heat sterilization
- 3) Glass bead sterilization
- 4) Chemical vapour sterilization
- 5) Ethylene oxide sterilization





## Steam autoclave sterilization



Steam sterilization (autoclave) uses saturated water vapor at 240° F, with 15 pounds of pressure for 15 to 40 minutes. The time can be reduced to three minutes by raising the pressure to 30 psi and the temperature to 270° F. More time is required for heavily wrapped loads of instruments.

Sterilization can be verified with indicators and spore tests. It is a time-tested method that has little value for orthodontists because it severely rusts pliers and damages cutting edges. The corrosion may be reduced by dipping the instruments in a milk-like emulsion of oil in water prior to sterilization.



## **Dry heat sterilization**

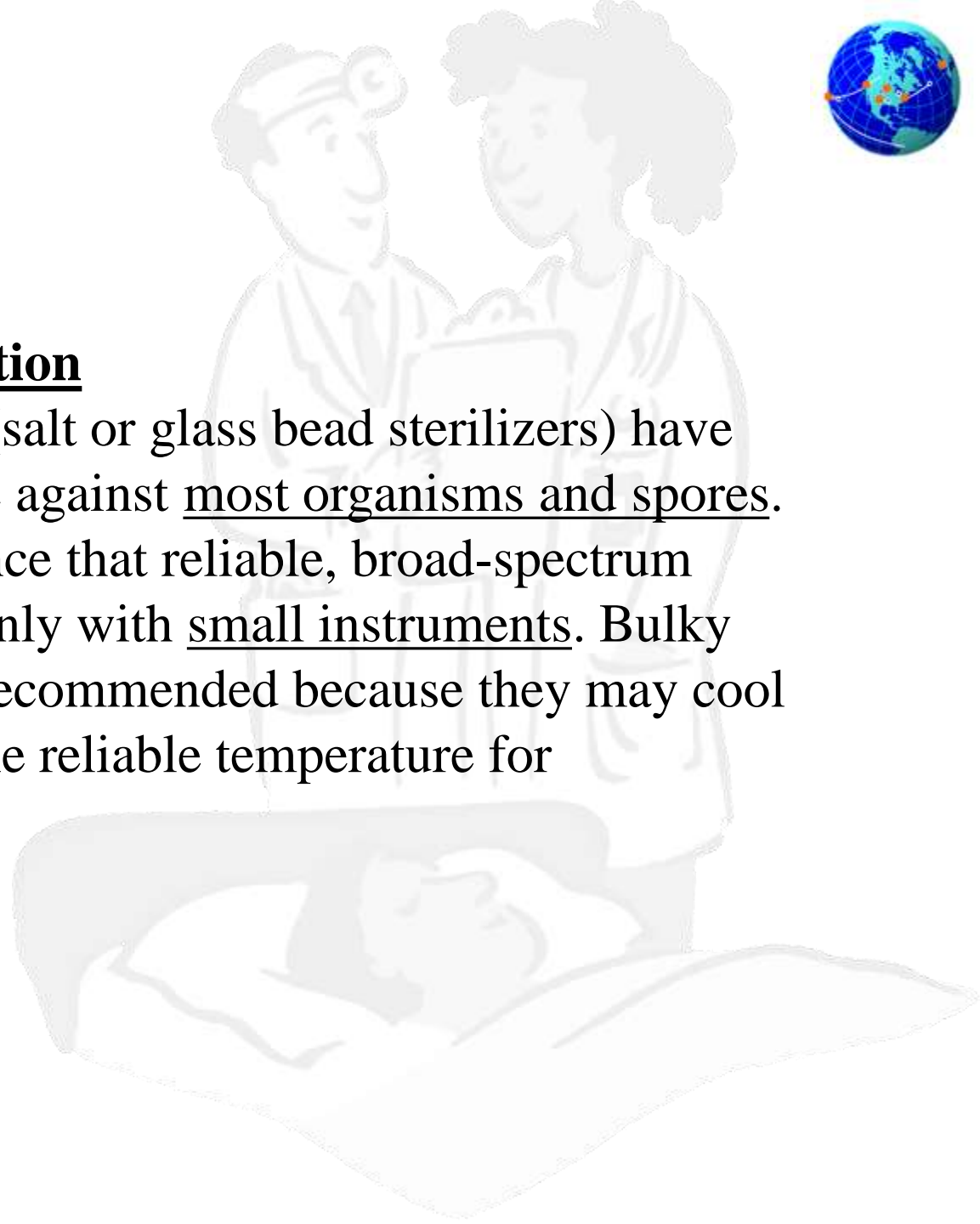
Dry heat provides a relatively low-cost sterilization procedure. Dry heat ovens require one hour at 320-340°F for sterilization. Wrapping or increasing the number of instruments increases the time required. It has two major drawbacks. It requires from 1 to 2 hours at 320° F for a complete cycle— far too long being practical for inventory considerations. A lesser problem is the tendency for the air to stratify and cause uneven temperatures that result in a lack of sterility.

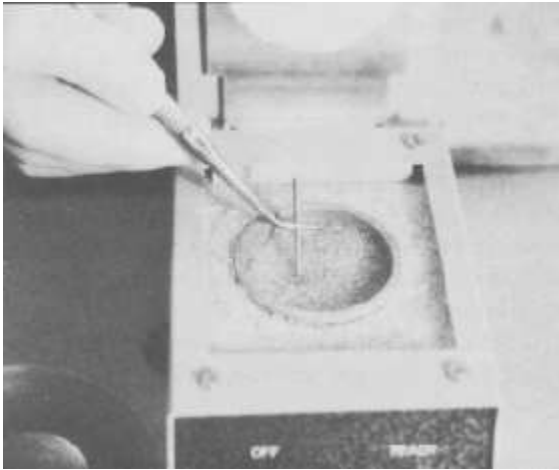




## **Glass bead sterilization**

Heat transfer media (salt or glass bead sterilizers) have been shown effective against most organisms and spores. There is some evidence that reliable, broad-spectrum sterilization occurs only with small instruments. Bulky instruments are not recommended because they may cool the medium below the reliable temperature for sterilization.





Glass bead sterilization uses small glass beads ranging from 1.2 to 1.5 mm in diameter. The suggested heating range is 424° to 450° F (217° to 232° C) for 3 to 5 seconds but not exceeding 482° F (250° C).

A relationship exists between the size and working surface of an instrument and the temperatures attained in the bead sterilizer. The larger the instrument, the longer the heat-up time required.

A narrow, deep well is preferable to a wide, shallow one; instruments should be placed deep and near the sides of the wall for best results.



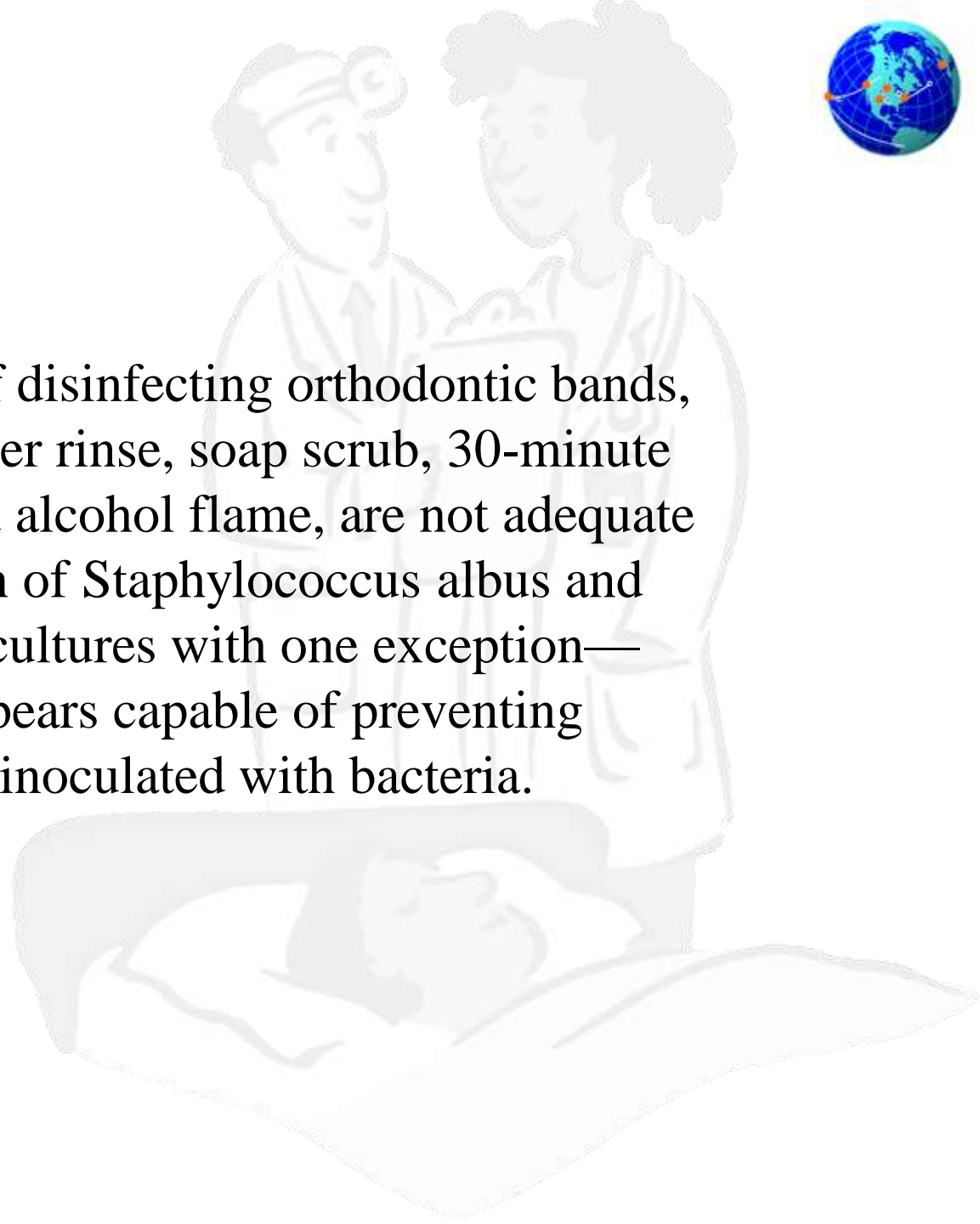
**Gerald E. Smith in AJO 1986** determined the capability of glass bead sterilization in sterilizing orthodontic bands and compared bead sterilization to other methods of cleansing and disinfecting orthodontic bands used in the office setting. The bands were placed one at a time into a 226° C bead sterilizer for 15, 30, 45, and 60 seconds.

The results indicated that 15 seconds is required to sterilize bacteria and 45 seconds required for spores.

A longer bead sterilization time is required if more than one band at a time is placed in the well. Twice the amount of time or 90 seconds is needed if five bands are inserted simultaneously due to the limited size of the well and fluctuation in temperatures with depth.



Other methods of disinfecting orthodontic bands, including tap water rinse, soap scrub, 30-minute alcohol soak, and alcohol flame, are not adequate to prevent growth of *Staphylococcus albus* and *Bacillus subtilis* cultures with one exception—alcohol flame appears capable of preventing growth on bands inoculated with bacteria.





## Chemical vapour sterilization



Unsaturated chemical vapor sterilization (Chemi-clave) is a suitable method for orthodontic instruments. Chemical vapor sterilizers use formaldehyde, alcohols, and water. The clean, dry, unwrapped instruments are set on a tray in the chamber, and the unit is set at 270° F at 20-40 psi for 20 minutes.



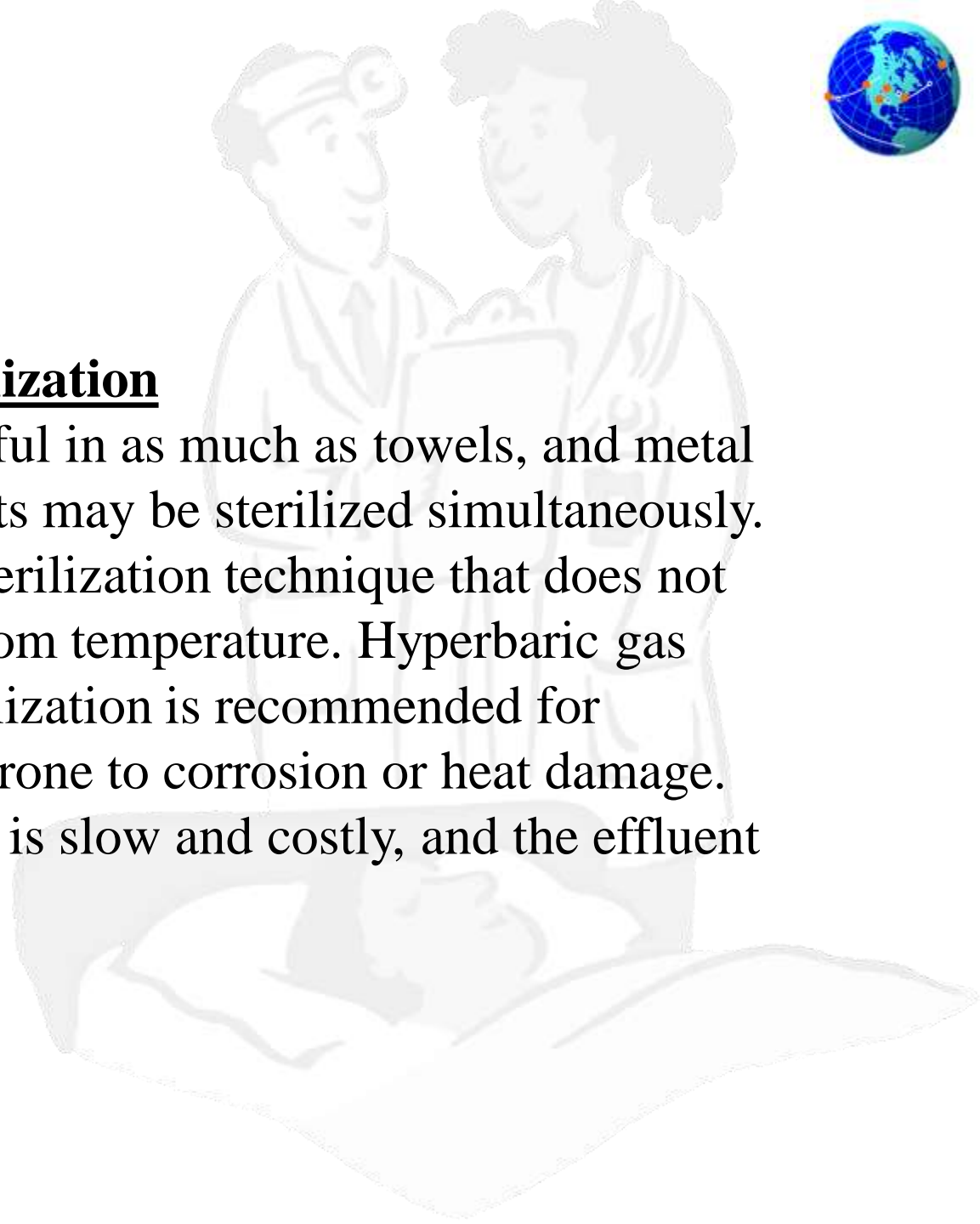
When the chamber is opened, the toxic formaldehyde vapor must be vented to the outside.

Because an unsaturated vapor is used, rusting is not a problem. It has a cycling time that is practical for an orthodontic office. Its chief drawback is a chemical odor that, although not harmful, requires adequate ventilation.



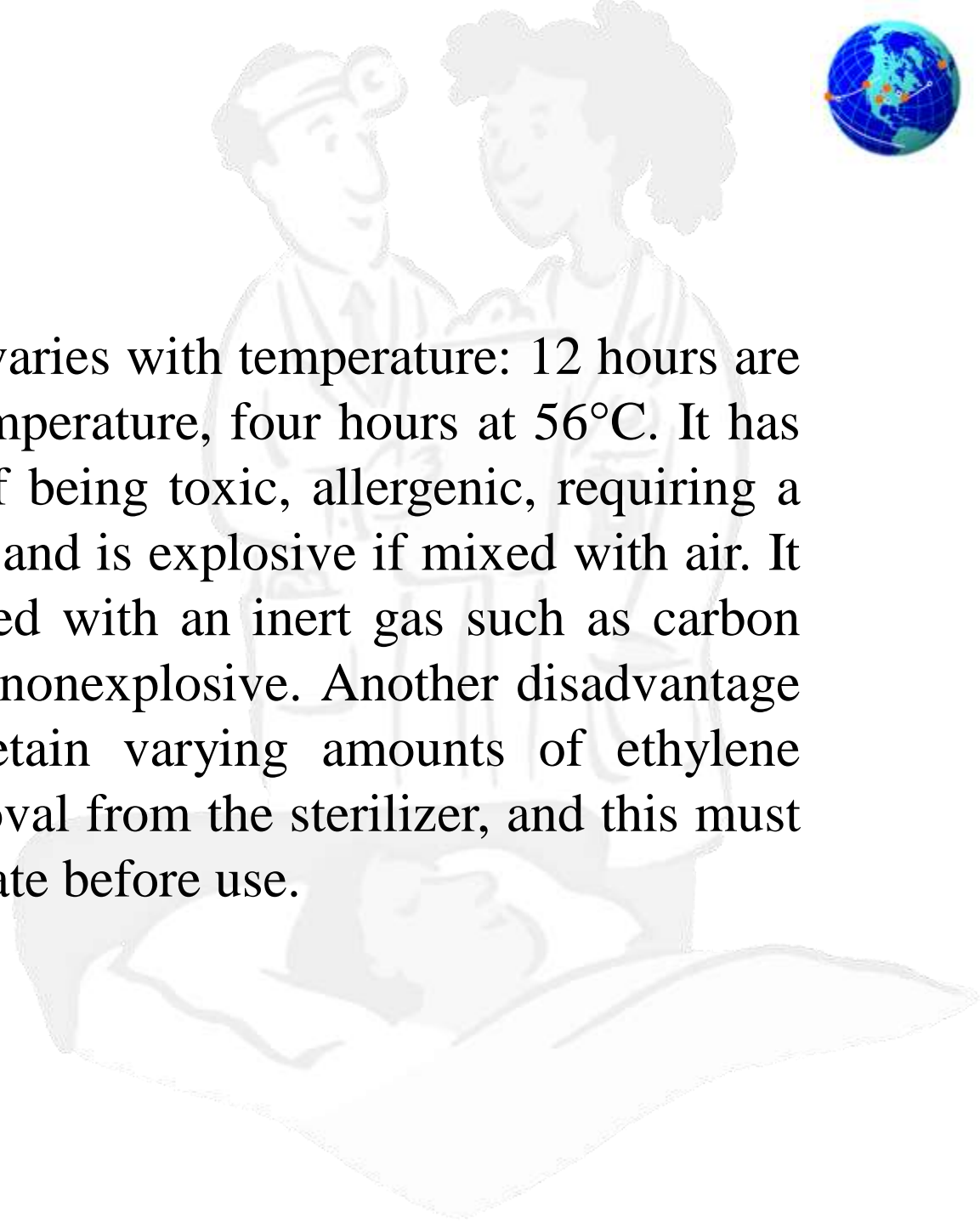
## **Ethylene oxide sterilization**

Ethylene oxide is useful in as much as towels, and metal and plastic instruments may be sterilized simultaneously. It is the only major sterilization technique that does not require heat above room temperature. Hyperbaric gas (ethylene oxide) sterilization is recommended for instruments that are prone to corrosion or heat damage. However, the process is slow and costly, and the effluent gas is highly toxic.





Standard treatment varies with temperature: 12 hours are required at room temperature, four hours at 56°C. It has the disadvantages of being toxic, allergenic, requiring a long exposure time, and is explosive if mixed with air. It is therefore combined with an inert gas such as carbon dioxide to render it nonexplosive. Another disadvantage is that materials retain varying amounts of ethylene oxide gas after removal from the sterilizer, and this must be allowed to dissipate before use.





Glutaraldehydes— alkaline, acidic, and heat-potentiated— are effective sterilants for instruments other than pliers, but only when used for 6 to 10 hours. Again, this is an impractical cycle time. Their best use is for plastics and other heat-sensitive items.

After heat sterilization, each rack of sterilized instruments is then kept in a cool-down drawer, which is lined with plastic laminate to control moisture, until the instruments and pliers can be returned to storage.

It is important that cutting instruments be rotated for periodic resharpenering. Plier hinges can be lubricated as necessary.



The most common inefficiencies in orthodontic sterilization procedures are overhandling of instruments and improper chairside clean-up. Contributing factors can include mislocation of the sterilization area, poor flow control of breakdown and sterilization, excess instrumentation, and poor storage organization.

Many orthodontists practice overkill procedures that are not required by any regulations, such as bagging individual instruments, wearing masks for all procedures, spraying chairs after every patient, maintaining an in-house laundry, and buying several different products when one will do the job.



# DISINFECTION AND ITS METHODS



A number of methods have been used in orthodontic offices to disinfect instruments and environmental surfaces. A 70% alcohol solution has been the most widely used even though the least effective. A 1% solution of sodium hypochlorite (bleach) is very effective, but hard on the skin and has an unpleasant odor. The iodophors are the best choice. They are inexpensive, have residual effectiveness, and are easy to use and store.

Their single drawback is the light brown residue left on surfaces, which disappears as the compound oxidizes. It does not stain as iodine does. These solutions can be made by diluting 1 oz povidone-iodine preparation in 16 oz of 70% isopropyl alcohol. They are also available in dry form to be diluted with water.



## Quaternary ammonium compounds (QAC)

A quaternary ammonium compound (QAC or "quat") reduces the surface tension between bacteria and an object, thus disrupting the bacterial cell wall.

Concentration, degree of contamination, level and extent of contact, and presence of other compounds all play a role in QAC effectiveness. Cotton, air, gross soil, or unusually heavy bacteria can prevent contact of the disinfectant with the cell wall. Combining several disinfectants— for example, a QAC with a phenolic compound containing an anionic detergent— can cause them to neutralize each other.



Quaternary ammonium compounds (QAC) are used routinely for hand instruments because the metal remains bright and shows no sign of corrosion. They have a pleasant odor and a short time cycle.

Disadvantages of QAC include, their inactivation by soap, reduced effectiveness in the presence of organic matter, incompatibility with many chemicals found in dental offices, and limited effectiveness against gram-negative organisms, spores, and viruses.



## **Phenol**

Phenol is not itself used as a disinfectant, but many disinfectants have been derived from it. At high concentrations, phenol is a rapid protoplasmic poison that penetrates the cell wall and precipitates the cell protein. The effectiveness of phenolic compounds depends on contact with the bacterial cell. These compounds are effective against vegetative bacteria, lipophilic viruses, and tuberculosis, but not against bacterial spores or hydrophilic viruses.



## **Alcohol**

Alcohol is a moderate disinfectant that behaves similarly to a QAC. Absolute alcohol is less effective than a 70 percent aqueous solution. Isopropyl alcohol is more effective than ethyl alcohol, but neither is effective against spores. Alcohol is generally bacteriocidal against vegetative forms. However, the American Dental Association (ADA) does not recommend alcohols, QACs, or phenolic compounds for use in dentistry, because they are nonsporicidal and ineffective against hepatitis B virus.



## Chlorine

Chlorine in aqueous solutions, even in minute amounts, is rapidly bacteriocidal. The exact mechanism of this activity is not known, but theories range from cell wall damage and enzyme system blockage to protoplasmic poisoning. Chlorine disinfectant should be prepared with distilled water and used on objects that have been cleaned of all gross soil, tissue, and contaminants.

Chlorine is effective against a wide spectrum of bacteria, entero-viruses, and spores, but chlorine solutions are unstable and must be made daily. Chlorine can corrode metals and soften plastics; it has a persistent odor and is irritating to eyes and skin. These disadvantages usually rule out routine use of chlorine solutions.



## Iodine

Iodine is a faster disinfectant than a QAC or chlorine. The free iodine forms salts with the bacterial protein, thus killing the cell. Iodine is effective against vegetative bacteria, spores, fungi, and certain viruses. Iodophors make effective surface disinfectants and are easily prepared by mixing iodine concentrate with softened or distilled water (hard water and some concentrations of alcohol will inactivate the iodine).

Other sources of disinfection include, but are not limited to, ultraviolet light, mercuric salts, hot oil, flaming, phenolic compounds, boiling water, and, more recently, microwaves.



# EFFECTS OF STERILIZATION & DISINFECTION ON ORTHODONTIC MATERIALS

## Orthodontic wires

**Smith and Von Fraunhofer in AJO 1992** studied the effect of clinical use and various sterilization/disinfection protocols on three types of nickel-titanium, and one type of  $\beta$ -titanium and stainless steel arch wire. The sterilization/disinfection procedures included,

- Disinfection → with an iodophor for 10 minutes
- Steam autoclave sterilization → sterilization temperature of 274° F (134.4° C) for 10 minutes.



- Cold sterilization→ freshly prepared sporocidin solution for 6.75 hours as per the manufacturer's recommendations.
- Dry heat sterilization→ sterilization temperature of 375° F (191° C) was maintained for 10 minutes.

The results indicated that load/deflection and tensile tests showed no clinically significant difference between as-received and used-then-disinfected/sterilized wires and they concluded that nickel-titanium arch wires could be recycled at least once.



**Sunil Kapila, Haugen and Watanabe in AJO 1992**

determined the effects of in vivo recycling interposed by dry heat sterilization (together referred to as clinical recycling, CR) on the load-deflection characteristics of nickel-titanium alloy wires (Nitinol and NiTi).

The results indicated that both dry heat sterilization (DHS) alone, as well as clinical recycling (CR), produced significant changes in the loading and unloading characteristics of Nitinol and NiTi wires.



However, the changes in the load-deflection characteristics of these wires after DHS only were relatively small, and the clinical significance of these changes is open to question.

In contrast, the force levels during loading and unloading were substantially increased for both types of wires after CR.

They concluded that, clinical recycling appears to reduce the "pseudoplasticity" and "pseudoelasticity" of NiTi wires and increases the stiffness of both NiTi and Nitinol wires.



**Mayhew and Kusy in AJO 1988** studied the effects of sterilization on the mechanical properties and the surface topography of 0.017 × 0.025-inch Nitinol and Titanal arch wires. Three approved heat sterilization methods were used namely,

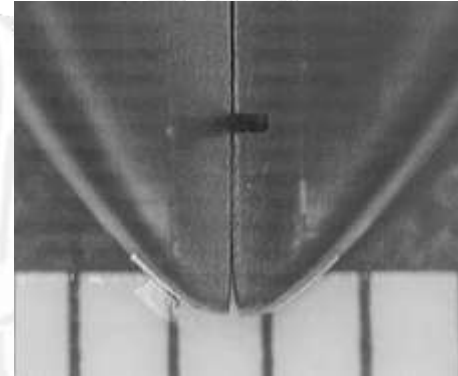
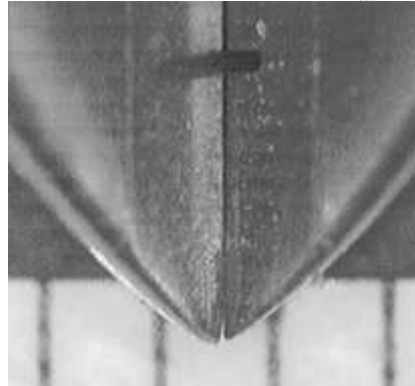
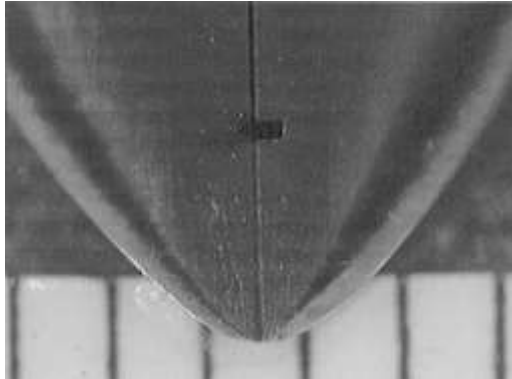
- Dry heat → applied at 180° C (355° F) for 60 minutes
- Formaldehyde alcohol vapor → formaldehyde-alcohol vapor pressure of 20 to 25 psi for 30 minutes at 132° C (270° F)
- Steam autoclave → at 121° C (250° F) and 15 to 20 psi pressure for 20 minutes

They concluded that neither the heat sterilization nor multiple cycling procedures had a deleterious effect on the elastic moduli, surface topography, or tensile properties of Nitinol or Titanal arch wires.

The bending moduli and the tensile strengths were approximately 10% greater for Nitinol than for Titanal.



## Orthodontic pliers



**Vendrell and Hayden in AJO 2002** compared the wear of orthodontic ligature-cutting pliers after multiple cycles of cutting stainless steel ligature wire and sterilizing with dry heat or steam autoclave. Fifty ligature-cutting pliers with stainless steel inserts were randomly divided into 2 equal groups to be sterilized in either dry heat or steam autoclave.



Each plier was subjected to a series of ligature wire cuts followed by the assigned sterilization method. The amount of wear at the tip of each plier in both groups was measured with a stereomicroscope system and digital photomicrography.

Orthodontic ligature-cutting pliers with stainless steel inserts showed no significant difference in mean wear whether sterilized with steam autoclave or dry heat. Steam autoclave sterilization can be used with no significant deleterious effects on pliers with stainless steel inserts.