Sterilization

Assis. Prof. Dr. Firas Albaaj

Sweeping infection control changes have permanently altered the way dentists deliver patient care. Among these advances are the use of aseptic procedures, latex gloves, masks, protective eyewear, over garments, scientific and safe handling of contaminated instruments, heat sterilization, chemical surface disinfectants, single-use disposables, and purpose- made disposable barriers.

Vaccination:-

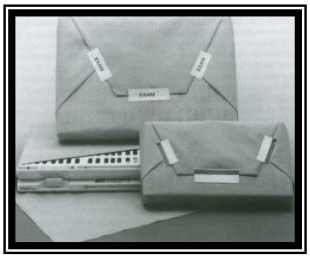
Dentists and dental health care workers who have direct patient contact are at risk of contacting or transmitting infectious diseases. Appropriate vaccinations for contagious diseases remain an important safety adjunct to infection control procedures. This is especially true for the hepatitis virus family. Dental health care workers should be immunized against hepatitis A& B.

Instrument preparation:-

The preoperative handling, cleaning and packaging of contaminated instruments are frequently sources of injury and possible infection. Dental staff performing such procedures should wear reusable, heavy rubber work gloves similar to household cleaning gloves. Contaminated instruments that will not be cleaned immediately should be submersed in a holding solution so that blood, saliva, and tissue will not dry on the instrument surfaces. Ultrasonic cleaner detergent, iodophor solution, or an enzyme presoak is an effective holding solution.

Use of an ultrasonic cleaner, which is many times more effective and safer than hand scrubbing, should be the choice for definitive instrument- cleaning sterilization. Instruments cleaned in an ultrasonic device should be suspended in a perforated basket. The cleaner should be run for at least 5 min. per load. Once the cycle is complete, the clean instruments must be thoroughly rinsed under a high volume of aerated water, placed on a clean, dry towel, rolled or patted, and air dried. The

ultrasonic solution becomes increasingly contaminated with each instrument load and should be discarded at least daily, and the tub of the ultrasonic machine should be disinfected. The contaminated instruments are now very clean, but they are not sterile. With cassette systems, the contaminated instruments are placed pack in the cassette holder and circulated through an ultrasonic cleaner or thermal disinfector, resulting in minimal hand contact by staff during instrument preparation. Instruments package in a cassette may require additional time in an ultrasonic cleaner or thermal disinfector, the manufacturer's recommendations should be strictly followed. Continued precautions are necessary until the instruments have been sterilized.



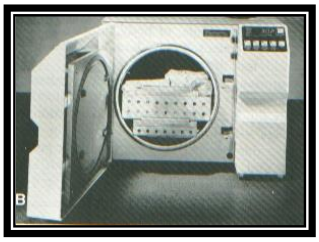
Clean instruments or cassettes ready for sterilization should be packaged in materials designed for the specific sterilization process to be used. The sterilizing agent must be able to penetrate the wrapping material and come into intimate contact with microorganisms.

Contaminated endodontic hand files must be cleaned in an ultrasonic bath and autoclaved to completely eliminate microorganisms and measurable endotoxin.

Methods of sterilization:-

The most reliable agent for destroying microorganisms is heat. Methods for sterilization in endodontic practice include steam or chemical vapor under pressure, dry heat, and glutaraldehyde solution.

Steam under pressure:-



The autoclave is the most common means of sterilization, except when penetration of steam is limited or heat and moisture damage is a problem. Moist heat kills microorganisms through protein coagulation, RNA and DNA breakdown, and release of intracellular constituents of low molecular weight. The autoclave sterilizes in 15 to 40 minutes at 121°C (249.8° F), at a pressure of 15 PSi. The time required for sterilization depends on the type of load placed in the autoclave and its permeability. Once the entire load has reached the desired temperature of 121°C, it will be rendered sterile in 15 min. An adequate margin of safety for load warm- up and steam penetration requires an autoclave time of at least 30 min. If there

is any doubt as to the safety margin required, the clinician should always allow more time for load warm- up.

Existing chamber air is the most detrimental factor to efficient steam sterilization. Modern autoclaves use a gravity displacement method to evacuate this air, thus providing a fully saturated chamber with no cold or hot spots. Instruments and packages placed in an autoclave must be properly arranged so that the pressurized steam may circulate freely around and through the load. Because recirculation of water tends to concentrate contaminants in an autoclave, only fresh, deionized (i.e., distilled) water should be used for each cycle. Several manufacturers now provide countertop water distillers that simplify autoclave operation. Caution must be exercised to never allow amalgam containing teeth or instruments to be sterilized in an autoclave, because mercury vapor will be released during the heat of sterilization and could pose a health risk or contaminate the autoclave. When instruments are heated in a steam autoclave, rust and corrosion can occur. Chemical corrosion inhibitors, which are commercially available, will protect sharp instruments.

Several rapid- speed autoclaves have been developed primarily for use in dentistry. Some of these devices may limit the chamber load size but have a sterilization cycle much shorter than the traditional steam autoclave.

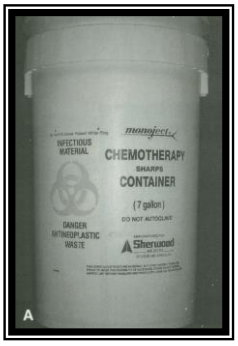
Advantages include: -

1- Turnaround time for an instrument is relatively quick.
2- Packages and internal areas of hand pieces are penetrated.
3- The process will not destroy cotton or cloth products.
4- Sterilization is verifiable.

Disadvantages include: -

1- Materials must be air dried at completion of the cycle.
2- Because certain metals may corrode or become dull, antirust pretreatment may be required. However, most stainless steels-resistant to autoclave damage.
3- Heat-sensitive materials or devices can be altered or destroyed with repeated sterilization cycles.

Unsaturated chemical vapor:-



This system, using a chambered device that is like an autoclave, is known as a Harvey chemiclave or chemical vapor sterilizer. The principle of chemiclave sterilization is that although some water is necessary to

catalyze the destruction of all microorganisms in a relatively short period of time, water saturation is not necessary. Like autoclave sterilization, chemical vapor sterilization kills microorganisms by destroying vital protein systems. Unsaturated chemical vapor sterilization uses a solution containing specific amounts of various alcohols, acetone, ketone, and formaldehyde, and a water content well below the 15% level where rust and corrosion occurs. When the chemiclave is heated to 132°C (270°F) and pressurized to at least 20 PSi, sterilization in the chemiclave requires careful arrangement of the load to be sterilized. The vapor must be allowed to circulate freely within the chemiclave and penetrate instrument- wrapping material. Chemiclave solution must not be recirculated; a fresh mixture of the solution should be used for each cycle.

Advantages: -

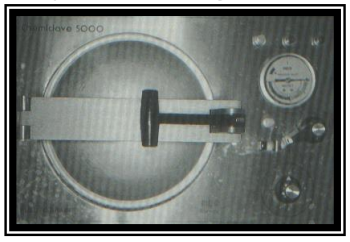
1- Process will not corrode metals.
2- Turnaround time for instruments is relatively quick.
3- The load comes out dry.
4- Sterilization is verifiable.

Disadvantages: -

1- Vapor odor may be offensive, requiring increased ventilation.
2- Special chemicals must be purchased and inventoried.
3- Process can destroy heat- sensitive materials.
4- Process may not penetrate the intricate internal workings of hand pieces as well as steam.

Dry heat:-

There are complicated factors associated with sterilization by dry heat. The time and temperature factors may vary considerably according to heat diffusion, amount of heat available from the heating medium, amount of available moisture present, and heat loss through the heating containers walls. Dry heat kills microorganisms primarily through an oxidation process. Protein coagulation also takes place, depending on the water content of the protein and the temperature of sterilization. Dry heat sterilization, like chemical vapor and autoclave sterilization, is verifiable, however, dry heat is very slow to penetrate instrument loads, it sterilizes at 160°C (320°F) in 30 min. but instrument loads may take 30 to 90 min. to reach that temperature. A margin of safety requires instruments to be sterilized at 160°C for 2 hours.



An internal means of determining and calibrating temperature is an essential component of any dry heat sterilizer. If the sterilizer has multiple heating elements on different surfaces, together with an internal fan to circulate air, heat transfer becomes much more efficient. It's important that loads be positioned within the dry- heat sterilizer so that they do not touch each other. Instrument cases must not be stacked one upon the other, and hot air must be allowed to circulate freely within the sterilizer.

High concentrations of mercury vapor can develop in a dry- heat sterilizer that has been used to sterilize amalgam instruments. Great care must be exercised to keep scrap amalgam out of any sterilizing device. Once contaminated with mercury or amalgam, a sterilizer will continue to produce mercury vapor for many cycles.

Small chamber, high- speed dry heat sterilizers have been developed primarily for use in dentistry. Load limitations exist, but these devices are much faster than prolonged dry heat. This type of sterilizer has the advantages of prolonged dry- heat, without many of the disadvantages of that sterilization method.

Advantages: -

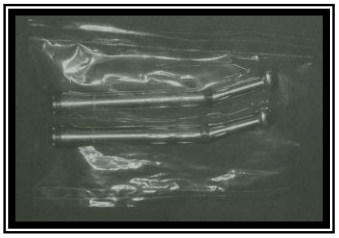
1- Process accommodates a large load capability.
2- The process offers complete corrosion protection.
3- Sterilization is verifiable.

Disadvantages: -

1- Process provides slow instrument turnaround because of poor heat exchange.
2- Sterilization cycles are not as exact as in moist- heat sterilization.
3- Dry-heat sterilizer must be calibrated and monitored.
4- If the sterilizer temperature is too high, instruments may be damaged.

Hand piece sterilization:-

Dental hand pieces and related instruments should be sterilized between patients to help prevent cross- infection. Continued improvement in design has made repeated sterilization of dental hand pieces possible. To reduce problems related to sterilization such as loss of torque, turbine wear, and fiber- optic degradation, the manufacturer's instructions should be strictly followed.



Glutaraldehyde solutions:-

Whenever possible, reusable dental instruments should be heat sterilized by a method that can be biologically monitored. However, some dental and medical instruments are destroyed or damaged by the heat of sterilization. In these cases, the use of aqueous glutaraldehyde preparations for high- level disinfection or sterilization can be used.

The biocidal activity of glutaraldehyde may be adversely affected by substandard preparation of activated glutaraldehyde, contamination of the solution by protein debris, failure to change the solution at proper time intervals, water dilution of residual glutaraldehyde by washed instruments that have not been dried, and the slow but continuous polymerization of the glutaraldehyde molecule. Instruments contaminated with blood or saliva must remain submerged in glutaraldehyde long enough for spore forms to be killed. Sterilization may require 6 to 10 hours, depending on the product used.

Advantages: -

1- Solution can sterilize heat- sensitive equipment.
2- The process is relatively non corrosive and nontoxic.

Disadvantages:-

1- Process requires long immersion time.
2- Solution has some odor, which may be objectionable, especially if the solution is heated.
3- Sterilization is non verifiable.
4- Solution is irritating to mucous membrane (e.g. eyes).

Monitoring sterilization: -

There are two methods commonly used to monitor in-office sterilization: -

1- Process indicators: -

Process indicators are usually strips, tape, or paper products marked with special ink that changes color with exposure to heat, steam or chemical vapor. The ink changes color when the items being processed have been subjected to sterilizing conditions. However, a process indicator usually does not monitor the length of time that such conditions were present. There are specific process indicators for different methods of sterilization. The process indicator’s main role in infection control is to

prevent accidental use materials that have not been circulated through the sterilizer. A color change in a process indicator does not ensure proper function of the equipment or that sterilization has been achieved.

2- Biologic indicators:-

Biologic indicators are usually preparations of non pathogenic bacterial spores that serve as a challenge to a specific method of sterilization. If a sterilization method destroys spore forms that are highly resistant to that method, then it's logical to assume that all other life forms, including viruses, have also been destroyed. The bacterial spores are usually attached to a paper strip within a biologically protected packet. The spore packet is placed between instrument packages or within an instrument package itself. After the sterilizer has cycled, the spore strip is cultured for a specific time.

Lack of culture growth indicates sterility.

Causes of sterilization failure include:-

1- Improper instrument preparation.
2- Improper packaging of instruments.
3- Improper loading of the sterilizer chamber.
4- Improper temperature in the sterilization chamber.
5- Improper timing of the sterilization cycle.
6- Equipment malfunction.

Methods of disinfection:-

Disinfection, which does not kill spore forms, should be reserved for the cleaning and decontamination of large surfaces, such as counter tops and dental chairs. Surface disinfectants approved by the Environmental Protection Agency (EPA) include iodophors, synthetic phenolics, and chlorine solutions. Surface disinfectants should have an EPA registration number and should be capable of killing mycobacterium tuberculosis in 10 min. Sodium hypochlorite, or household bleach, in a dilute solution can be used to wipe down environmental surfaces. The surface to be disinfected should be kept moist for a minimum of 10 min. (30 min. is ideal). The free chlorine in solution is thought to inactivate sulfhydryl enzymes and nucleic acids and to denature proteins. Sodium hypochlorite is extremely biocidal against bacterial vegetative forms, viruses, and some spore forms. However, it's corrosive to metals and irritating to skin and eyes.

Iodophors are combinations of iodine and a solubilizing agent. The manufacturer's recommendations for dilution must be strictly followed to achieve the optimal amount of free iodine in the disinfecting solution. Iodophors have a build- in color indicator that changes when the free iodine molecules have been exhausted. This method of disinfecting offers an effective, practical approach without the problems associated with other disinfectants.

Sterilization of gutta- percha:-

The sterilization of gutta- percha cones is of importance in endodontic practice because this material may come in intimate contact with periapical tissue during obturation.

Immersing gutta- percha cones in 5.25% sodium hypochlorite for 1 min. is very effective in killing vegetative microorganisms and spore forms. Gutta- percha can also be decontaminated by immersing cones for 1 min. in 1.0% NaOCl or for 5 min. in 0.5% NaOCl.

Effect of repeated sterilization on instruments:-

The effect of repeated sterilization on the physical characteristics of endodontic files has been studied. Repeated sterilization of stainless steel endodontic files, using any heat method described in this lecture, will not cause corrosion, weakness, or an increased rate of rotational failure.