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## **INSTRUMENTS STERILIZATION PROTOCOL IN DENTAL COLLEGES WITH MORE THAN 200 DENTAL CHAIRS**

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### **ABSTRACT**

Infection control is an essential part of the healthcare system that deals with the prevention of hospital acquired or general healthcare associated infection. Infection control is of high importance as if not done effectively, it can lead to an increased spread of diseases that can threaten life. Although rendering proper services to patients is of high importance, the maintenance of sterility while doing so is of greater importance to avoid the transmission of infection diseases. Dentistry is one of the leading healthcare systems that employs the usage of hand instruments in almost every sitting and hence, the chances of infection spread is extremely high. The need for sterilization, i.e., the complete removal of microorganisms is hence of utmost importance. Guidelines issued by the CDC (Center for Disease Control) are required to be followed for the maintenance of sterility. The most commonly used device for sterilization procedures is a hot air oven which was later replaced by an autoclave that employs the principle of sterilization 'Steam under Pressure'. The sterilization protocol in dental colleges is reviewed in this article and Saveetha Dental College having more than 200 dental chairs was taken into consideration to review the sterilization protocol.

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## INTRODUCTION

Infection control primarily deals with prevention of hospital-acquired or generally, healthcare-associated infection. It is an essential part of the health care that is practised within a particular health care system (Padberg, 2015). It is of high importance in general practise due to the danger of causing viral infections such as HIV or Hepatitis B (Smith, 1965). Research done confirms a connection between the spread of diseases acquired from hospitals and the hands of health care workers (Boyce, Pittet and Healthcare Infection Control Practices Advisory Committee. Society for Healthcare Epidemiology of America. Association for Professionals in Infection Control. Infectious Diseases Society of America. Hand Hygiene Task Force, 2002). Dentistry is one of the core healthcare sectors that makes use of hand instruments at almost every sitting. Mouth is the mirror of various systemic diseases that includes cancerous lesions, or any other communicative disease. Hence, decontamination is the primary initiative to be taken into consideration in dental primary care (Porter, 2009).

Sterilization is the process that is predetermined to eliminate all the bacteria present on the surface. The potency of the steriliser can be deduced by three ways —

mechanical indicators on the steriliser itself, heat sensitive tapes or indicators that change the colour according to the levels of heat or steam, and finally biological testing where a microorganism that is heat or chemical resistant is selected; the steriliser is selected if it can kill the microorganism (Miller (Microbiologist) and Palenik, 2018).

A marked steriliser of today's medical field is an Autoclave. A medical autoclave is a device that utilizes steam to sterilise the instruments, thereby getting rid of all the bacteria, fungi, viruses and spores. Generally, instruments are autoclaved at 121°C for about 15 minutes or 134°C for about 3 minutes. Though some bacteria, for example - *Geogemma barossii* can reproduce and successfully, it is not found to pose a threat on human health. Autoclaves are found in many of the medical sectors but today, many procedures utilise single use instruments rather than reusable instruments. Once steriliser in a vacuum autoclave, the instrument can be preserved for about 12 months in a sealed pouch.

One of the most used sterilisers today is the Hot Air Oven. Developed originally by Louis Pasteur, it is an electrical device that sterilises using dry heat (Smith, 2014). A standard setting of a hot air oven is 160°C

for 1.5 to 2 hours; 190°C for 6 to 12 minutes; additionally including the time to preheat the chamber itself before the sterilization process. Unlike the autoclave, it doesn't require water making it safer to handle in a laboratory environment. They are comparatively smaller than the autoclave however as effective as an autoclave. The process is faster as high temperatures are achieved at a faster rate. Disadvantage of this is that the use of dry heat may not be very successful to inhibit some organisms and that the surgical instruments lose their sharpness.

Recent advances in the sterilization of instruments has paved a way for easier and effective sterilization with the use of articles commonly found in dental clinics. Chlorhexidine (Selvakumar NP, 2017) has been tested for sterilization of instruments and has been found to reduce a significant number of colony forming bacterial units in various surgical instruments and are found to be useful in sterilization of orthodontic appliances such as brackets (Shahana and Muralidharan, 2016). *Enterococcus faecalis*, *Staphylococcus aureus* (Ashwin and Muralidharan, 2015) (Pavez *et al.*, 2019) have been reported to be found in increased levels in instruments used for root canal treatments. The elimination of the bacteria is hence of high importance.

Certain guidelines are issued by the CDC - Centres for Disease Control and Prevention in the view of sterilization of instruments. In these, the instruments are classified into 3 types - Critical, Semicritical, Noncritical items and the disinfection and sterilization processes follow accordingly (Ananthanarayan, 2009). Previously our team has a rich experience in working on various research projects across multiple disciplines (Muthukrishnan and Warnakulasuriya, 2018), (Govindaraju, Neelakantan and Gutmann, 2017), (Chen *et al.*, 2019), (Priyanka *et al.*, 2017), (Sitharthan *et al.*, 2019), (Priyadharsini *et al.*, 2018), (Azeem and Sureshbabu, 2018), (Wu *et al.*, 2019), (Abitha and Santhanam, 2019), (Manohar and Abilasha, 2019), (Venu, Dhana Raju and Subramani, 2019), (Wang *et al.*, 2019), (Girija, Jayaseelan and Arumugam, 2018), (Sheriff, Ahmed Hilal Sheriff and Santhanam, 2018), (Dhinesh *et al.*, 2017) Now the growing trend in this area motivated us to pursue this project.

The sterilization protocol that is used in dental college is reviewed in this article. Saveetha Dental College boasting umpteen dental clinics, hence having more than 200 chairs was taken into consideration to review the sterilization protocol followed.

#### STERILIZATION TECHNIQUES USED IN DENTISTRY:

Sterilization is the most required process to be performed in the healthcare system. It is the process of removal of microorganisms, to prevent the spread of infectious diseases. The most apparent form of sterilization is incineration, but this method cannot be employed as many of the instruments used in dentistry are required to be recycled. Hence, the leading form of sterilization employed in today's time is autoclave (Fraise, Lambert and Maillard, 2008).

#### **Autoclave:**

Autoclave is a method of sterilization that involves the employment of 'steam' under pressure for sterilization. When heat is applied to water in a closed system, the vapor pressure increases, becoming close to the atmospheric pressure. This leads to the vaporization of water and is referred to as the boiling point, where the vapor pressure and the atmospheric pressure are equal (Anderson, 2014).

The normal atmospheric pressure is 760 mmHg and the normal boiling point of water is 100 degrees. This temperature, however, does not help in the killing of endospores; which require temperatures above 100 to be killed. To conquer this disadvantage, the boiling point has to be increased somehow to ensure the lysis of microorganisms. This requires an artificial increase in boiling point which must be done by increase in the pressure. This is the

principle of an autoclave (Black, 2019). The increase of pressure within the closed chambers of the autoclave causes an increase in the boiling point of water (over 100 degrees) leading to the lysis of the endospores.

*Geobacillus stearothermophilus* is the indicator used for checking the accuracy of the sterilization (Donk, 1920). Autoclave is used for the sterilization of glass, pre-treatment of wastes and surgical instruments (Wallace, 2016) and cannot be used for the sterilization of rubber, plastic and other heat-labile instruments. Nonetheless, autoclave ensures proper sterilization of surgical instruments that can be employed for use in treatment.

#### **Ethylene Oxide:**

Ethylene oxide is a cyclic ether and forms a strong bond with oxygen that strongly pulls against each other which makes them extremely reactive when used with other ethers. Ethylene oxide is used for the sterilization of critical items that are unable to withstand high levels of heat and temperature such as plastics and rubber (Wallace, 2016). It is present frozen, as the compound has an ability to explode and hence must be handled with care (McDonnell, 2007).

It enters the cell by penetration, reaching towards the DNA of the microorganism and ensures their lysis by the process of

alkylation (Abreu *et al.*, 2013). Although this method of sterilization may be useful, it is extremely harmful to the human body and is a pollutant to the environment (Dancer, 2014).

#### **Hydrogen Peroxide vapor or plasma:**

Hydrogen peroxide plasma is made of many anions, cations, hydroxyl and hydrogen peroxide radicals. The plasma penetrates the instruments and ensures complete sterilization unlike ethylene oxide and requires only a short duration for the process as well. The only disadvantage of this process is that it is a little expensive (Rutala, Gergen and Weber, 1998).

#### **GUIDELINES OF CDC (Centers for Disease Control and Prevention)**

Earle H. Spaulding about 3 years ago devised a coherent approach in sterilization of equipment that stated that the instruments were to be classified as critical, semi critical and noncritical according to the level of risk that it has the ability to cause (O'Hara, Thom and Preas, 2018).

#### **Critical Items**

These items have the highest risk of causing infections if contaminated with any organism. Therefore, any object that enters the tissue or the vascular system ought to be sterile as it has the ability to cause contamination—leading to diseases, if infested with microorganisms. Critical Items include surgical instruments,

implants or probes. Heat-sensitive items must be sterilised with EtO, Hydrogen Peroxide has plasma or by liquid sterilants. Liquid sterilants produce considerable results if followed with proper guidelines ('Guidelines for Preventing Health-Care-Associated Pneumonia, 2003: Recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee', 2004). Chemical sterilants include germicides— 7.5% hydrogen peroxide, 7.35% hydrogen peroxide with 0.23% peracetic acid.

#### **Semicritical Items**

These items are those that come in contact with the mucous membranes or non-intact skin. Semicritical items include endoscopes, cystoscopes (Rutala and Weber, 2013). Though these should ideally be free from all microorganisms, it is permissible to have a slight number of bacterial spores intact. Generally, Semicritical items require high level disinfection. High level disinfection means the complete removal of all the organisms in or on the instrument excluding a few bacterial spores. FDA defines high level disinfection as the sterilant used for shorter contact time to achieve a 6-log kill of an appropriate Mycobacterium species. Usually, these instruments or items are sterilised between patients to prevent the spread of bacteria. Forced drying with air

does help in marked removal of bacterial contamination in mostly stored endoscopes (Wendt, Widmer and Frei, no date; ‘Guidelines for Preventing Health-Care-Associated Pneumonia, 2003: Recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee’, 2004).

### Noncritical Items

These are the types of items that come in contact with intact skin but not the mucous membrane. Intact skin provides an efficacious barrier against most of the microorganisms; therefore, the sterility of items are not critical in this case. Examples of some non-critical items include crutches, computers, bedpans. Unlike the critical and semicritical items, these are not required to be transported to a central processing area and then decontaminated. There is practically no risk of being contaminated by a non-critical item as there has been no records of transmission of microorganisms. Noncritical surfaces are those surfaces under contact of hand often which could contribute to secondary transmission by contamination of hands. These however are not required to be cleaned and disinfected on a day to day basis (Kampf *et al.*, 2005). Since 1981, there has been considerable changes made by the CDC guidelines for disinfection and sterilization. Firstly, formaldehyde-alcohol was eliminated as

the recommended sterilant. Secondly, many combinations with hydrogen peroxide have been added as new sterilants. Thirdly, 3% phenolic and iodophors has been removed from high level disinfectants as it doesn’t efficiently remove bacterial spores such as *M.tuberculosis*. Fourthly, isopropyl alcohol and ethyl alcohol has been removed from the list of high level disinfectants as it doesn’t inactivate the hydrophilic viruses. Fifth, 1:16 dilution of 2% phenol, 7.05% phenol, 1.20% sodium phenate has been removed from high level disinfectants due to its inability to eliminate bacterial, fungal, tuberculocidal and sporicidal activity. Sixth, the exposure time required to accomplish a raised disinfection has been changed to 12 minutes or more according to the FDA-cleared label or scientific literature.

### APSIC GUIDELINES FOR STERILIZATION OF INSTRUMENTS:

The guidelines issued by APSIC (Asian Pacific Society of Infection Control) have issued guidelines for the sterilization and disinfection procedures of instruments employed in the healthcare system. It aims in providing a high standard of sterilization to curb the spread of infectious diseases (Ling *et al.*, 2018). Maintenance of a proper sterilization technique is of high importance for the safety of the patient (‘Guidelines for Prevention of

**Transmission of Human Immunodeficiency Virus and Hepatitis B Virus to Health-Care and Public-Safety Workers', 1989).** The aforementioned Spaulding's classification is used for the analysis of the reprocessing of instruments. Reprocessing is the process of disinfection, cleaning, remanufacturing, testing, packing among various other procedures to ensure the use of the instrument again (**Spratt et al., 2012**).

Recommendations for reprocessing as given by APSIC are as follows:

1. Critical and medical surgical devices that enter sterile tissues must be sterilised before use.
2. Steam sterilization is a preferred method in the sterilization of critical medical and surgical instruments if they are not damaged by heat, steam, pressure or moisture.
3. High level of disinfection is required to sterilise the critical medical or surgical equipment.
4. Non-critical items used are to be disinfected only when they appear to be soiled visibly and on a regular basis.
5. Standard disinfection and sterilization procedures are required to be followed when the equipment is used for patients affected by blood borne pathogens like multiple drug resistant microorganisms.
6. Methods not acceptable for sterilization are:
  - (i) Boiling
  - (ii) Ultraviolet Light
  - (iii) Glass bead sterilization
  - (iv) Microwave oven
  - (v) Chemiclave sterilization
7. Needles must be single use and are not be reprocessed.
8. Health care settings must have a written policy for instruments meant for single use.
9. Critical and semi-critical single use instruments must not be reprocessed unless it is done by a licensed reprocessor.
10. Catheters and other instruments with single lumen (excluding endoscopes) must be single used.
11. Reprocessing must be done, if possible in a centralised area that complies with the physical and human requirements of reprocessing.
12. Individuals performing the sterilization/disinfection procedure must be trained in the science and methods of the same at the start of their employment and yearly. It is also important that the person undergoes competency training.

13. Persons performing high-level disinfection should be aware of the proper usage of PPE (Personal Protective Equipment) according to the method used.

Other than the above mentioned guidelines, the APSIC has provided additional guidelines for the storage and release of sterilised instruments, maintenance of reprocessing instruments, reprocessing of endoscopic instruments and recommendations in education and training.

### **Sterilization protocol in large dental colleges with more than 200 dental chairs:**

#### **Articles which are sent for sterilization:**

- Mouth mirror
- Tweezers
- Straight Probe
- Explorer
- Williams probe
- Periosteal elevator
- Needle holder
- Tissue holding forceps
- Maxillary anterior forceps
- Maxillary premolar forceps
- Maxillary right molar forceps
- Maxillary left molar forceps
- Bayonet forceps
- Mandibular anterior forceps
- Mandibular premolar forcep
- Mandibular molar forcep

- Coupland elevator
- Cryer's elevator
- Kidney tray
- Endodontic files
- Spoon excavator
- Teflon coated instruments
- Ball burnisher
- Cone burnisher
- Clamps
- Diamond carver
- Reusable intra oral mirror
- Hollenback carver
- BP Handle
- Curettes
- Scaler tips
- Metal impression trays
- Metal cheek retractors
- Hand scalers
- Nabers probe
- WHO Probe

#### **Practices and Guidelines:**

Centralized sterilization process. This policy outlines recommendations for practices in sterilization of instruments. The process of sterilization involves cleaning, packaging and supply of instruments to the respective operative theatre, wards and clinics. The process is strictly monitored to ensure optimal sterility at all times. All policies are developed and reviewed annually.

#### **Pre cleaning:**

Initial decontamination begins immediately after the completion of any invasive procedure. Instruments are kept free of gross soil by washing with water. Manual cleaning is done in a controlled environment using standard precautions. The instruments are rinsed, dried, packed and sent to the central sterile supplies department. The work area should be disinfected after every instrument cleaning.

#### **Decontamination:**

Decontamination of all instruments is done in the CSSD using 2% glutaraldehyde. The instruments are placed in a wide mouthed chemical resistant plastic container containing 2% glutaraldehyde for 15 mins. then, the instruments are transferred to stainless perforated trays and rinsed thoroughly in running tap water. After the rinsing, the instruments are scrub washed using detergents or enzyme cleaner. The best method is to use ultrasonic cleaner for 45 mins. Then the instruments are dried in a hot air oven at 80°C for 30 to 45 mins and packed.

#### **Packaging:**

The selection of the packaging system is based on recommended guidelines and is compatible with the sterilization process. Single wrap is made and sealed. All are appropriately labelled with date, batch number and autoclave number.

#### **Sterilization cycle:**

- The choice of sterilization procedure is based on the manufacturer's written instruction. The packs to be arranged so that there is little resistance to the passage for steam. All packages are placed in the sterilizer on edge in a vertical to allow free air circulation and penetration of steam.
- Heating phase in which the steam is brought to proper temperature and allowed to penetrate all around. Autoclaving is done at 15 lbs for 30 mins at a temperature of 121° C. Drying and cooling phase in which the objects are dried and cooled. Steam evacuation systems are recommended in all autoclaves to quickly dry the moisture and to prevent rusting of instruments. They are stored in ambient temperature on stainless steel racks. Every sterilized item has a chemical sterility indicator, batch number and date of sterilization. Shelf life of instruments/linen wrapped items considered sterile for one week.

#### **Monitoring of sterilization:**

Sterilizer functions are monitored using mechanical, chemical and biological indicators to meet all standards.

1. Biological indicator every 15 days.

2. Chemical indicator every load.

**Recall Procedure:**

In case any biological indicator is found positive, it is immediately informed to the infection control team or the nursing supervisor.

A variant report would be prepared that would include:

1. Time and date of the questionable sterilization cycle.
2. Identification of the sterilizer.
3. Description of the loads and lots control number.
4. Results of mechanical monitoring wherever feasible.
5. Result of chemical indicator.
6. Any information relevant to the validity of the test or human error.
7. After the corrections have been made, the sterilizer would be retested with a biological indicator.
8. Several consecutive cycles of sterilization would be monitored. Until the results of the biological test are satisfactory, the sterilizer would be quarantined.
9. Record is maintained.

**CONCLUSION**

Infection control is a necessary measure for the prevention of the spread of infectious diseases. The healthcare system is often at a high risk in the transmission of diseases if proper sterilization protocol is not

followed. The oral cavity has a wide range of microorganisms that may be responsible for many systemic disorders. Sterilization is hence highly essential for the maintenance of safety standards and to provide proper patient care. Implementation of proper protocol in the process of sterilization is therefore of extreme importance and must be followed.

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**CONFLICT OF INTEREST:**

Nil.

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