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Newer Sterilization Methods

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In day-to-day clinical practice dentists face with many kinds of micro-organisms because of their professions that require intimate contact with their patients. Thus, sterilization and disinfection methods should be implemented meticulously and their effectiveness carries a crucial importance for the physician and the patient's health. Assurance of sterility of instruments and devices can be obtained through the use of one of several tests and these tests must be performed regularly to ensure that the sterilizer is sterilizing all instruments and devices and that these are safe for use on patients.

Key words: sterilization, ozone, plasma.

On a daily basis, the practicing dentist and his personnel are at risk of being exposed to a wide range of patients with blood-borne diseases such as HIV/AIDS, hepatitis B, hepatitis C, and airborne diseases such as Influenza and Tuberculosis (Deer, 2004; Ozer, 2005). Sterilization is the process that destroys all types and forms of micro- organisms including viruses, bacteria, fungi and bacterial endospores. Concerns about the transmission of infectious agents, such as the Hepatitis B virus (HBV) and the Human Immuno deficiency Virus (HIV) have caused more awareness on the need to adequately sterilize and disinfect instruments and other equipments to protect both the doctor our patients.[1] Infection can be directly transmitted by oral fluids, blood, contaminated instruments and surfaces or via the respiratory system (Toroglu et al., 2001; Shah et al., 2009). Thus the use of various dental instruments and materials in clinical practice demands a thoroughly designed sterilization procedure to render the instruments free of all microbial life, including bacterial spores, which can be very difficult to kill.[2-4] This article highlights, the various newer sterilization methods.

Newer methods of sterilization

It includes,

1. Ultrasonic cleaners
2. Radiation
   a) UV rays
   b) Microwave
   c) Ionizing radiations
      i) Beta particles
      ii) Gamma rays
2) Hydrogen peroxide plasma / vapor sterilization
3) Low temperature gas / plasma sterilizer
4) Ozone gas sterilization

Ultrasonic cleaners

It utilizes a mechanism by which, a high frequency electrical energy is converted into mechanical energy, by metallic or piezoelectric transducers. The mechanical energy is in the form of high frequency sound wave vibrations. They are used as a pre-sterilization procedure, efficient in removing organic soils from instruments and glassware.

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Radiation sterilization

It utilizes electromagnetic energy which affects cells in varying ways depending upon the wavelength, intensity and duration of the energy.[5,6] They are of three types

Ultraviolet radiation

It utilizes low-pressure mercury vapor lamp that generates UV rays which has microbicidal effect. The bactericidal range of UV rays is between 2400 to 2800A$^{o.}$

Microwave sterilization

Microwave sterilization uses a low-pressure steam with non-ionizing radiation to produce the localized heat, which kills the microorganisms. The temperature is lower than conventional steam.[7,8] The sterilization cycle is as short as 30 seconds.

Ionizing radiation

Ionizing radiation produces ions by knocking out the electrons from the atoms. These electrons are knocked out so violently that they strike an adjacent atom and either attach themselves to it or dislodge an electron from the second atom. The ionic energy thus produced is converted into thermal and chemical energy. This energy kills microorganisms by disrupting the DNA molecule. This prevents the cellular division and propagation of the microbes. However, the drawback of this is that the physical properties of some materials are altered by exposure to ionizing radiation. This limits the usage of ionizing radiation.

1) The principal source of ionizing radiation are,
   a) Beta particles
   b) Gamma rays

Beta particles

1) These are free electrons which is transmitted through a high-voltage electron from a linear accelerator.
2) These high-energy free electrons penetrate into matter before being stopped by collisions with other atoms.
3) Thus their usefulness in sterilizing an object is limited by,
   a) The density and thickness of the object
   b) The energy of the electrons.
4) They produce their effect by ionizing the atoms on collision. This produces secondary electrons which has a lethal effect on the microorganisms.

Gamma rays

1) Gamma rays are electro-magnetic waves which have the capability of penetrating greater depth than beta rays before losing their energy from collisions.
2) They travel at the speed of light and pass through large bulky objects before making sufficient collisions to lose all of their energy.
3) It is cost-effective for the manufacturer.

Hydrogen peroxide plasma / vapor sterilization

Plasma is a state of matter distinguishable from solid, liquid or gas. It is activated to create a reactive plasma or vapor by using high frequency waves.[9,10] This cloud of plasma created consists of ions, electrons and neutral atomic particles that produce a visible glow.

Its advantage are

(a) The process is dry and nontoxic
(b) The by-products of oxygen and water vapor can be safely evacuated into the room atmosphere.
(c) Aeration is not necessary.
(d) A low temperature allows safe sterilization of some heat-sensitive items like endoscopes and fiber optic devices.
(e) Corrosion does not occur on moisture – sensitive, microsurgical and powered instruments.
(f) The sterilizer is simple in design and connects to standard electrical outlets.

Its disadvantages are

a) Metal trays should not be used as it blocks the radio-frequency waves
b) Hydrogen peroxide is not compatible with cellulose (woven textiles with cotton fibers and paper products).
c) Nylon becomes brittle after repeated exposure to hydrogen peroxide sterilization.

Low temperature gas / plasma sterilizer

A solution of water and 58% hydrogen peroxide is vaporized by radio frequency energy to create pink, glowing reactive plasma.[11] The reactive particles in the plasma are maintained at 104^{o} F (40^{o}C). It can sterilize the heat and moisture-sensitive instruments in approximately 1 hour. No aeration is necessary because the by-product is primarily oxygen and water.

Ozone gas sterilization

Ozone sterilizes by oxidation that destroys organic and inorganic matter. It penetrates the membrane of cells causing them to explode.[12,13] It

is an unstable gas but can be generated easily from oxygen and water.

Its advantages are,

1. The sterilizer generates its own agent using hospital oxygen, water and the electrical supply.
2. It is simple and inexpensive to operate.
3. Ozone gas sterilization provides an alternative to ETOX gas sterilization of many heat and moisture-sensitive items.
4. It does not affect titanium, chromium, silicone, neoprene and Teflon coated instruments.
5. Aeration is not necessary
6. Ozone does not leave any residue and converts to oxygen in a short time.

Its disadvantages are

1. Ozone can be corrosive.
2. It will oxidize steel, iron, brass, copper, and aluminum
3. It destroys natural rubber such as latex, natural fibers, and some plastics.

CONCLUSION

A high degree of sterility assurance is of critical importance for the sterilization process. Safe and effective sterilization practice is essential that staff performing the sterilization procedure should have an in-depth-knowledge and understand the scientific principles and methods of sterilization, its parameters, applications, and risks associated with each method. Each sterilization cycle should be verified with mechanical, chemical, or biological indicators. Knowing and understanding the scientific principles of various sterilization methods and their proper applications, as well as the monitoring and record keeping requirements can help to ensure effective sterilization, patient safety, and cost-effectiveness.

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