

Sterilization and Disinfection

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Moist heat: Moist heat at high pressure, also known as steam sterilization, is the simplest and most frequently used method of heat sterilization. Moist heat alone (boiling water at 100 °C) can effectively kill most organisms, but spores easily survive. The use of moist heat at high pressure raises the boiling point of water to produce steam at a temperature that can effectively kill spores and achieve sterilization. Both pressure cookers and autoclaves use heat under the pressure of steam to eliminate organisms. Unlike dry heat, some hard plastics can be safely sterilized in this manner, such as orthopedic implants or some laparoscopic equipment.

Steam sterilization has four parameters: steam, pressure, temperature, and time. Standard sterilization procedures use steam at 121 °C (250 °F) at 15 psi (pounds per square inch) for 20-30 minutes, which effectively kills all spores to achieve sterility in a gravity displacement autoclave. At higher temperatures of 134 °C (273 °F), sterilization can be achieved in four minutes, if a pre-vacuum autoclave is used. Note that instruments packaged in kits with multiple layers, as well as liquids, require longer times in the autoclave.

Type of Sterilizer	Item	Exposure time at 121°C (250°F)	Exposure time at 132°C (270°F)	Drying time
Gravity displacement	Wrapped instruments	30 min	15 min	5-30 min
Gravity displacement	Textile packs	30 min	25 min	15 min
Gravity displacement	Wrapped utensils	30 min	15 min	15-30 min
Prevacuum	Wrapped instruments	N/A	4 min	20-30 min
Prevacuum	Textile packs	N/A	4 min	5-20 min
Prevacuum	Wrapped utensils	N/A	4 min	20 min

Minimum cycle times for steam sterilization; adapted from CDC (reference at end of Chapter.)



If the release valve fails, the autoclave can be turned into a dry heat autoclave, which creates higher temperatures and will

likely melt any plastics in the device (in this case sizers for a knee arthroplasty set.).

Flash sterilization is a modification of the standard steam sterilization that sterilizes unwrapped items at 132 °C for 3-4 minutes at 27-28 psi. It is designed for use only in emergency situations, when there is not enough time for a standard sterilization cycle. Items to be sterilized must have already gone through the proper cleaning and decontamination process. Since items are unwrapped, contamination can occur as soon as the item is removed from the sterilizer, increasing the risk of infection. Flash sterilization should be avoided for any implantable devices, and it should not be used as a method for convenience.

Filtration: Filtration can be useful if an IV medication used during a procedure must be sterilized, since heat or chemical sterilization will denature drug compounds. Micropore filters with pore sizes of 0.2 µm will remove bacterial cells, but not viruses. Filtration of viruses requires a pore size of 20 nm.

Irradiation: Ultraviolet radiation has poor penetration, therefore, it can only be used to sterilize surfaces. Other forms of ionizing radiation, such as gamma rays, are associated with higher costs and harmful effects on equipment compared to other methods of sterilization. Therefore, sterilization via irradiation is not recommended.

Chemical methods:

The most common chemical methods are iodine, alcohols, chlorine derivatives, glutaraldehyde, hydrogen peroxide, peracetic acid, enzyme solutions, and ethylene oxide. Not all chemicals can be used for sterilization, even with increased exposure time, and careful consideration of proper storage and disposal of these chemicals must be taken when selecting the appropriate agent to use.

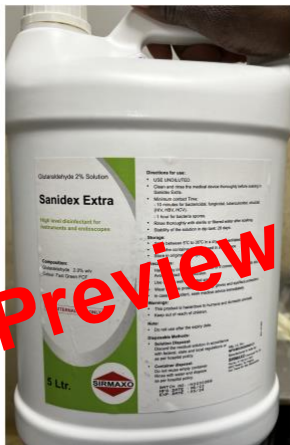


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Enzymatic cleaner, a mixture of protease, amylase, lipase, carbohydrase, and “proprietary enzymes.” This is mixed with (non-sterile) water according to the manufacturer's instructions- the mixture is changed daily.

Glutaraldehyde: This solution, also known as “Cidex” is a chemical solution that can be used for cold disinfection. It requires a pH >7, with greatest efficacy at pH 9-10. Items are submerged in a ≥2% solution for 20-90 minutes at 20 °C to achieve high-level disinfection or 10 hours to achieve sterility. This solution can be reused for 14-30 days. Note that this solution can be quite toxic, therefore proper PPE and procedural care must be taken to avoid inhalation or skin contact. Although it is widely used in the healthcare setting, especially for disinfection of endoscopic equipment, this solution may not be legal in all countries.



2% Glutaraldehyde solution: this is not to be diluted. .

Hydrogen peroxide can be used to achieve high-level disinfection via a 7.5% solution for 30 minutes at 20 °C. Sterilization can be obtained by increasing contact time to 6 hours. This solution can be reused for 21 days.

Peracetic acid at a concentration of 0.2% at 50-56 °C can be used to achieve sterility when items are submerged for 12 minutes. A solution of 7.35% hydrogen peroxide with 0.23% peracetic acid can be used to achieve high-level disinfection at 20 °C for 15 minutes. Increasing exposure time to 3 hours is effective for sterilization. In addition, this solution can be reused for 14 days.

Ethylene oxide: This is a poison gas that very effectively sterilizes laparoscopic equipment as well

as plastic materials since it does not use heat or moisture. A concentration of 700 mg/L can sterilize at 38 °C (100.4 °F) in eight hours and at 54 °C (129 °F) in four hours. However, this method is not readily available, as it requires a special ethylene oxide chamber, and the used gas must be destroyed either via a sulfuric acid scrubbing mechanism or catalytic oxidation. In addition, this gas is explosive. Therefore, in resource-limited settings other methods should be used for disinfecting/sterilizing certain equipment such as rubber, fragile plastic or laparoscopic cameras.

PRACTICE

Given that this topic is vast and sprawling, focus will be placed on a few topics related to common practices: general operating room layout for optimal sterilization, a case-based walk through of general sets to be taken after an operation, and finally a few tips for operating common sterilization tools. Remember, the steps to achieve sterilization include cleaning, decontamination / cleaning, disinfection, and sterilization.

Operating room and sterilization area design.

The operating room has a network of support areas/rooms that allow it to function: decontamination area, packing area, sterilization area, and sterile supply room. Each of these distinct zones are necessary within your operating facility to keep operations going.

Decontamination area: This area is the first stop after an operation is completed. It has a sink used for mechanical removal of any bioburden, via high pressure water, air, or manual scrubbing. It also has an area for submersion disinfection (i.e enzymatic cleaner or glutaraldehyde.) It is physically separated from the other areas to reduce risk of cross-contamination.

