

SIMPLIFIED PREDICTABLE STERILIZATION

GEORGE FREEDMAN

Over the last few years, there has been a quantum leap in the understanding of the microbial threats that exist in the dental practice. Coincidentally, many new diseases and potentially dangerous organisms have also been identified. Fortunately, these threatening trends have been accompanied by a tremendous advance in the science and technology of in-office sterilization and disinfection.

While sterilization can be a complicated and confusing subject, we as dental professionals must possess a good basic knowledge of this area of dentistry; our patients' health and lives may depend on it. Our staff members rely upon our leadership in this area for their personal protection. Furthermore, our own health (as well as that of our families) and continued practice as dental practitioners are predicated upon our ability to apply the best current science and technology to sterilization and disinfection in our offices.

Much of the confusion that surrounds decontamination can be traced to the lack of simplified, straightforward information and conflicting advertising claims in three specific categories:

- 1) basic definitions with respect to sterilization and disinfection
- 2) autoclave cycle classification
- 3) standardized techniques and outcome evaluations

Definitions in sterilization

Cleaning. The technique of removing visible contamination from a dental instrument or surface, either through physical scrubbing (manual decontamination), an energy/chemical process (ultrasonic cleaning), or the innovative, automated washing of instruments that ensures that they are thoroughly cleaned, free of debris and ready for effective sterilization. The automated method of washing instruments eliminates the need to pre-soak or scrub instruments. This process should be used only as a preamble to sterilization, and is of course totally unacceptable as a standalone procedure for dental instruments.

Disinfection. The destruction of microorganisms, pathogenic or otherwise, by physical or chemical means. This process destroys most known pathogens but may not affect bacterial spores. In the dental practice, the concept of "most but not all" pathogens is a very questionable path to follow. The risk of the surviving pathogens causing cross infection is a major one indeed.

Sterilization. The destruction of all viable microorganisms, including many of the resistant bacterial spores, by a physical (including heat) or chemical process. Since this process covers the broad range of pathogens that may be found in the oral cavity and in the teeth, it is the only clinically acceptable means

for dealing with reusable instruments between patients.

Classification of autoclave cycles

The various types of autoclave cycles¹ are differentiated by what they will or will not sterilize and how long they take to complete the process. In terms of sterilization material targeting, the two most important parameters are whether the instruments are solid or hollow, and whether they can be wrapped, or must be left unwrapped. The concept of "porous load" also plays a big role in cycle definition.

It makes sense that a sterilizing agent will have more difficulty penetrating and sterilizing a hollow object such as a handpiece than surface-contacting a solid object such as a dental mirror. The chemical or physical agent can be simply passed over a solid surface, while it must be forced or sucked into internal spaces that have constricted access. It is important to remember that many dental instruments are "hollow", in that they have lumens or difficult-to-access areas. The key issue is that the air trapped inside these hollow areas cannot be easily removed to allow the sterilant to contact the instrument surface.

The sterilizing agent also takes longer to penetrate to instruments through wrapping than simply contacting unwrapped ones. The wrapping effectively envelops the instruments in a "hollow" into which the agent must be forced or sucked. On the other hand, the convenience and organization of wrapping instrument "kits" together can greatly increase practice efficiency, and hence practice success. Another advantage of wrapping is that the instruments maintain their sterility during storage. The ideal sterilization cycle for the dental practice is one that can handle both hollow and solid instruments, wrapped or unwrapped.

The least noticed phase of sterilization is the drying time. Instruments or wrapped packs should be allowed to dry inside the sterilizing chamber prior to removal and handling. If they are handled while they are moist and hot, the packing can act as a wick, absorbing moisture and bacteria from the outside, and transporting them to the instruments inside.

The **N-cycle** is suitable for sterilizing unwrapped, solid instruments. N-cycle sterilizers are the most popular bench top autoclaves, and are classified as passive systems (also known as gravity, non-vacuum, or downward displacement). Typically, as steam is admitted into the sterilization chamber, it forces unsaturated and saturated air out through a vent. The major concern with the N-cycle sterilizers is the non-removal of trapped air (especially air pockets in lumens and difficult-to-access areas of the load) during gravity displacement. Errors in packaging or overloading the sterilizer chamber can result in cool air pockets where items are not sterilized.²

George Freedman, DDS, FAACD, FACD (Canada)

Table 1. Small Sterilizers

Cycle type	N-cycle	B-cycle	S-cycle
Materials than can be sterilized	solid only	solid/hollow	solid/hollow
	non-wrapped only	multi-wrapped/ non-wrapped	wrapped/non-wrapped
		porous	
Air removal	gravity-displacement	forced	pressure pulsed
Cycle time (without drying)		47 minutes	6-9 minutes

The **B-cycle** is used to sterilize solid, hollow, and porous instruments, be they wrapped or unwrapped. It involves the use of active (forced) air removal, usually with a vacuum pump. These prevacuum sterilizers are usually fitted with a pump that creates a vacuum that removes air from the sterilizing chamber before the chamber is pressurized with steam. This technique allows faster and more effective steam penetration throughout the entire instrument load than the gravity displacement technique typically employed in sterilizers with N-cycles. Any air that is not removed from the chamber will interfere with steam-instrument contact, and may compromise sterilization. B-cycle sterilizers must be tested periodically for adequate air removal.

The **S-cycle** is indicated for unwrapped solid products; porous, hollow, single-wrapped products; or multi-layer wrapped products. Thus, all dental instruments can be sterilized with this cycle. The S-cycle utilizes forced air removal, this action being created by vacuum or steam pulsing. The positive pressure pulse system removes air from the sterilization chamber without a vacuum pump. Pressurized steam is injected into the chamber, gradually forcing the air out through a valve. Once the chamber is pressurized, the chamber is vented to near-atmospheric conditions. This process is repeated multiple times until effective air removal is achieved. Some S-cycle autoclaves use Positive Pressure Pulsed Air Displacement to offer a sterilization cycle that is specifically designed for clinical convenience in that they are able to sterilize products effectively (with validation) with reduced cycle times.

The length of the cycle time is the other important issue in selecting a sterilizer. The longer the cycle time, the more instrument sets and handpieces a busy practice requires. In fact, the estimated purchase cost of a single operative set, including low and high speed handpieces, can easily cost \$3000 or more. Thus, a quick turnaround time for the validated sterilization process can be of major benefit to the financial health of the practice.

The time required for a sterilization cycle is dependent on a number of factors. The type of cassette (light, thin cassette walls promote rapid heating and cooling) and the size of the sterilization chamber are both critical; the smaller the chamber, assuming that it is large enough for the typical instrument load, the more quickly air can be removed and steam and pressure introduced. Expelling the excess steam at the end of the cycle

will speed up the drying stage and shorten the cycle time.

Since the limitations of N-cycle sterilization make it impractical for dental office utilization, the clinical choices should be limited to B- and S-cycle autoclaves. The B-cycle sterilizer takes a minimum of 47 minutes to complete versus the 6-9 minutes of a pressure pulsed S-cycle (without drying). From a strictly time management point of view, the pressure pulsed autoclave systems make the most sense. Furthermore, since the S-cycled instruments (particularly expensive and delicate handpieces) spend less time in the corrosive environment of hot air and moisture, this technology offers not only a quicker but also a more gentle sterilization for the dental practice.

Validation

Manufacturers should be able to provide autoclave users with microbiological validation confirming that their autoclaves are effective in sterilizing the instruments that they are indicated for, under the conditions listed in the instructions.

Furthermore, each autoclave must be monitored on a regular basis to ensure the ability of the equipment to attain the physical parameters that are required to achieve effective sterilization. This can be accomplished with chemical, biological, and temperature monitoring test kits. These tests can be cumbersome, however, and are easily forgotten.

Conclusion

In-office sterilization of instruments between patients need not be a difficult or complicated process. A simplified description of the sterilization and disinfection options available quickly guides practitioners to the one that is most suitable for their dental offices. A quick overview of the different sterilization cycles, their benefits and limitations, their utility and utilization times, further guides decision making. Finally, the validation process provides sterilization confidence to the dental professional, and assurance to the dental staff and patients.

Overall, the guiding principles in sterilization, as in other dental areas, should be proven and demonstrable effectiveness in destroying pathogens, ease-of-use in a daily clinical setting, and practical efficiency.

References

1. Voluntary European Standard EN 13060:2004
2. Guidelines for Infection Control in Dental Health-Care Settings 2003