Plasma Sterilization: Mysteries Unveiled

By: Pamela H Caudell, RN, CNOR, CSPDS, ASCP

Objectives:
Describe what plasma sterilization is
Discuss how plasma is made
Describe how plasma is used in the sterilization process

Plasma was named after an American physicist, Irving Langmuir. Plasma refers to a group of positive ions and electrons with an electric charge created by an electrical discharge, and plasma physics is the study of the physical properties of plasma. Plasma is considered to be the fourth (4^{th}) state of material and 99% of all the materials in space are plasma. Plasma sterilization is known to have started in the great year of 1968, when Menashi reported the use of a pulsed RF (radio frequency) field to kill spores (106) in time scales on the order of seconds rather than minutes.
Electrical plasma, used in sterilization, can be classified into two types broadly: volume and surface plasma. Plasma is classified as volume plasma when it is generated by injecting a gas at a specific flow rate into a chamber fitted with electrodes and grounded sufficiently. When the circuit was closed, the gas inside the chamber would be subjected to an electric field and hence ionized, creating plasma. Surface plasma is usually when the electrodes (power and ground) are embedded into a dielectric and hence plasma is generated on the surface of the dielectric itself.

Now that we've done the hard to understand stuff, let's break it down into an understandable language. The reason we look at sterilization itself is because up until now, we have had reputable methods of sterilization, steam and gas that will sterilize almost everything. Those items that couldn't be re-sterilized were considered to be disposable. However, with the increasing cost of medical care, we can't afford just to throw things away. Also, the newer pieces of equipment are more expensive, more delicate, more intricate, and as a consequence, do not hold up under the steam and gas sterilization processes. Ergo, plasma sterilization is the newest sterilization process in our arsenal of safe sterilizations. Another reason we look at plasma sterilization is the amount of time it takes to run a cycle. If we use ethylene oxide, the cycle takes anywhere from 8-16 hours depending on the manufacturer and the set-up of the machine. If plasma is used, the cycle usually takes anywhere from 45 to 75 minutes for wrapped and dry instruments and devices at which time these products are ready for use. One of the nice things about this sterilization type is the lower temperatures of sterilization. Temperatures are maintained in the 104-122 F (40-50 C) range. This helps ensure the delicate instruments we are now seeing in our units are being maintained without any damage. With the use of a plasma sterilizer, the sterilization cycle can do more than one item at a time, depending on the size of the sterilizer. Another advantage to using this type of sterilization over the peracetic acid process happens at the end of the cycle. Peracetic acid sterilization is an at-point-of use sterilization. In other words, the item sterilized must be used within a very short period of time as this is a wet sterilization and there isn't any way to store the sterilized items. With the plasma sterilization process, the items are wrapped or placed in sterilization containers that meet criteria so that at the end of the cycle, the items, if not used, can be stored on the shelf like any item that has been steam sterilized or Eto sterilized. Another reason to look at plasma sterilization is that it has no downside to the environment and poses no threat to either the staff using it or the patient receiving the sterilized items. The sterilized items have no down time waiting for an aeration cycle unlike ethylene oxide.
One of the down sides to this particular type of sterilization is it's inability to reach all the way thru certain lumens. The lumen size must be greater than 3 mm in diameter and the scopes must also be less than 400 mm long.
We can't use plasma sterilization for flexible scopes either. Another downside for the use of plasma sterilization deals with the wrappings. Paper items and cloth cannot be used to wrap instruments or peel pouch anything going into the sterilizer. In the sterilization process, the wraps used must be designed to specifically be used in plasma sterilizers.
The second part to this disadvantage hinges on the dryness of the item to be sterilized. If there is any wetness to the instrumentation being sterilized, the cycle will abort. Another downside to the plasma sterilization process is the inability to sterilize liquids, powders or any item containing cellulose as this will absorb the plasma.

1. T, 2. T, 3. F, 4. F, 5. T, 6. F, 7. T, 8. T, 9. F, 10. T

A hydrogen peroxide solution is dispersed into a vacuum chamber which creates a plasma cloud. The gas works by changing the cellular components of the microorganisms which causes them to be inactivated and destroys them. Once the sterilizer is turned off, the plasma cloud no longer exists. When the energy is taken away, water vapor and oxygen is formed. There is no toxic residue, harmful emissions or the need for environmental monitoring. There are five (5) phases of the hydrogen peroxide processing cycle:

♦ First is the vacuum phase. The pressure drops to less than one pound per square inch. This part lasts about 20 minutes.

♦ Next is the injection cycle where the liquid hydrogen peroxide is injected into the chamber where it is turned into a vapor which in turn creates a gas. This causes the pressure to rise caused by an increase in the molecules within the chamber.

♦ The third stage is called the infusion stage. Here the gas spreads throughout the chamber and the increasing pressure forces the sterilant into the packs. This exposes the instrument surfaces and kills the microorganisms.

♦ In the fourth phase, radio frequency waves are applied, causing some electrons to be removed from the molecules. This produces a low-temperature plasma cloud. After this reaction occurs, all active elements lose their energy and recombine to form oxygen and water. The first three phases are then run again to assure optimal sterilization for those items that are harder to sterilize.

♦ The final phase is the venting stage. This puts filtered air into the chamber and returns the chamber to atmospheric pressure so we, mere humans, can open the door

If the item can be changed by exposure to low pressure or the makeup of the plasma, this type of sterilization should not be used. If you have a product that is made of anodized aluminum, there is an increased risk of the item fading or turning colors with continued exposure to the hydrogen peroxide vapor that is produced.

Just like every other sterilization process, quality assurance monitoring has to happen. QA is always considered to be an ongoing process. Because of our alignment with the Association of Perioperative Registered Nurses, those of us working in the Central Sterile arena follow both the AAMI guidelines and the AORN guidelines for sterilization monitoring. The other guiding body is each facility's own policies and protocols. Each sterilization method has its' own biological indicator/ integrator. This is also true with the plasma sterilizer. *Geobacillus Stearothermophilus* is the spore used to test plasma sterilization. Most facilities don't just have one method of sterilization. Because of the variation of the items we are responsible for, most of us have two and sometimes three alternatives for sterilization. Only by studying our own instrumentation sterilization needs, the manufacturer's recommendations and our finances can we be informed

enough to make a decision on whether or not plasma sterilization is something we need in our own departments.

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1. Plasma was named after an American physicist, Irving Langmuir.
   True False
2. Plasma refers to a group of positive ions and electrons with an electric charge created by an electrical discharge
   True False
3. The newer, more delicate pieces of equipment we are now seeing, can be treated with steam without problems.
   True False
4. Plasma Sterilizer temperatures are maintained in the 170-240 F range.
   True False
5. Plasma sterilization poses no threat to either the staff using it or the patient receiving the sterilized items.
   True False
6. The same paper items and cloth used for steam sterilization can be used to wrap instruments or peel pouch anything going into the plasma sterilizer.
   True False
7. If the item can be changed by exposure to low pressure or the makeup of the plasma, this type of sterilization should not be used.
   True False
8. *Geobacillus Stearothermophilus* is the spore used to test plasma sterilization.
   True False
9. At the end of the plasma cloud formation, all active elements lose their energy and recombine to form alcohol and water.
   True False
10. The lumen size must be greater than 3 mm in diameter and the scopes must also be less than 400 mm long in order to be sterilized in a plasma sterilizer.
    True False

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