

Austere Medicine Sterilization



Sperans optimum ad pessimum praepara

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STERILIZATION

Microbes live and survive in all habitable, and even in some seemingly inhabitable environments. As a consequence of this many will be naturally present on medical instruments, dressing materials, sutures, and in water used to prepare and clean these items. If these microbes are not removed, then they will at the very least grow and contaminate your precious tools so that you will end up with potential surgical infections. In the worst case scenario, some of these organisms may be disease causing, and use of unsterilized instruments may lead to their inadvertent introduction into a wound and kill your patient.

In microbiological terms, sterilization refers to the complete elimination of all living organisms in or on the materials being sterilized. There are no degrees of sterilization; items are either sterile or not. For the above reasons, sterilization procedures are a vital aspect of medical care, and in the austere environment, the most effective and available methods all involve the use of heat to destroy microbes.

Chemical methods can also be used to sterilize instruments, but availability of chemicals and abundant microbe-free water to rinse instruments is likely to be

limited in the austere environment. In addition, heat can be used to sterilize linens, but wet chemical sterilization of linens is not practical and dry chemical sterilization is beyond the capability of 'most' austere medical providers.

Autoclaving

Of all the methods available for sterilization, moist heat in the form of saturated steam under pressure is the most widely used and the most dependable. Steam sterilization is nontoxic, inexpensive rapidly microbicidal, sporicidal, and rapidly heats and penetrates fabrics.

In microbiology laboratories the most widely-used method for heat sterilization is autoclaving. The autoclave is a large and complex machine that uses pressurized steam, heated to 121 °C, to destroy microbes. **Autoclave.** It's a term that comes down to us from the old French Academy of Science from over 100 years ago and it's about the door and the locking mechanism that is used on the equipment. The name stuck and medical steam sterilizers are now called autoclaves.

Over a 100 years ago, a steam sterilizer looked very much like an All American pressure cooker. But when they put a door on that was hinged with a locking mechanism with just one handle it was designated the autoclave. The only real difference between an office autoclave and a pressure cooker is the extra instrumentation offered in the autoclave. (And actually, you can buy the lid with the extra instrumentation from All American Pressure Cooker company that converts their stove-top pressure cooker into a stove-top autoclave. Conveniently for the medically trained prepper, a conventional pressure cooker can serve as a very effective autoclave for the austere environment.

The high pressure (typically 15 psi) allows the temperature to exceed 100 °C, the normal boiling point of water at atmospheric pressure. (See graph at end of article describing steam pressure/temperature.) As soon as the chamber of an autoclave is full of steam at the desired temperature and pressure, it must be held there for a critical time: the holding time. To achieve sterility (at roughly sea level altitude) , the steam must be applied at 15 psi for about 15-20 minutes. If this time, temperature, and pressure is carried out properly, the pressure cooker (autoclave) will inactivate all fungi, bacteria, viruses and also bacterial spores. An easy

minimum figure to remember is ‘**15 pounds for 15 minutes**’ (‘1 kg per square cm for 15 minutes’).



All American
Pressure Cooker



All American Autoclave

The All- American pressure cooker shown below left when used at the the highest weight setting (15lb) in an auto pop-off valve, will reach the elevated temperatures needed for sterilization. Instead of the older weighted pop-off valve, this has a geared steam gauge with, automatic overpressure release; settings of 5 psi, 10 psi, and 15 psi. On the right side is pictured the All American stove top sterilizer in the same size. Note the similarities. Maximum pressure 20 PSI in the sterilizer is a bit more than the auto pop-off valve in the pressure cooker (15lb). The stove-top sterilizer has a steam release valve.

From Amazon comments about this pressure cooker:

“One of the labs I supervised lacked funding to purchase an autoclave. We sterilized media broth, media agar, dilution agents, Petri dishes, flasks, bottles, and other microbiology utensils in a Mirro pressure canner. We sterilized a minimum of three batches daily, five and six days a week, year round. The Mirro canners constantly required new seals, yet the lids still frequently warped and leaked all over the stove. We replaced the Mirro canner twice in a year, let alone all of the gaskets we went through. I bought this All American pressure

cooker when I saw the unique no gasket design, securing lugs, and the safety features built into this pressure cooker. My micro staff loved this pressure cooker. This All American pressure cooker never leaked, the lid fit perfectly time after time, and all of our batches came out properly sterilized. It impressed me so much after almost two years' use in a laboratory setting, that I am now buying one for my home canning. Made in USA, heavily built, well-engineered for performance and safety, and proven to me in multiple daily uses with three different users, including myself--a great pressure cooker in my experience, far better than the others we tried.”

Commercial autoclaves designed for hospital and large clinic use have many additional features that enhance large tray processing, multiple package processing, and speed up the process through combinations of higher heat and more pressure. These features, together with automated and/or timed processing are designed to make sterilization of large packages of medical equipment rapid and convenient for the operator. The underlying basics of steam sterilization remain the same.

Please follow the instructions below to use your pressure cooker as an autoclave and note that these differ slightly from the instructions for its use in pressure cooking for reasons that are explained.

1. Put about 400 ml (1.75 cups) of water in the bottom of the pressure cooker. Distilled water is the best for this. This can be tap water in a pinch but if you live in a hard water area using bottled spring water or distilled water will prevent scaling of the device.
2. You need a rack on the bottom of the pressure cooker to prevent items being immersed in the water and becoming soaked. A metal trivet or similar device can be used as a rack.
3. Containers must have tops that can be fitted loose, and therefore vented, and should be capable of holding at least 20% more than the intended volume of medium, to allow for expansion during sterilization. If screw cap jars are used, the cap must be loosened prior to sterilization. **ALWAYS VENT BOTTLES TO PREVENT BURSTING.** Solid items can be wrapped in aluminum kitchen foil or double wrapped in cotton toweling, but will need to be dried afterwards (2-3 days in an airing cupboard) without opening the packet

to maintain sterility. Clearly, in an emergency, instruments can be used as soon as they are cool enough to handle.

4. Put on the lid and close the pressure cooker but do not yet put the weight on top on the steam valve.
5. Place the cooker on the heat source and turn to a high setting
6. Once the water in the cooker starts to boil, steam will come out of the open valve. Allow steam to pass out of the valve for about 5 minutes, and then put the heaviest weight (15lb) weight on top of the valve. (O set the pop-off valve to 15 lb). This step is important because it will ensure that all of the trapped air is removed. Air is a poor conductor of heat and too much air will decrease the efficiency of the sterilization process. The 15 pound weight will ensure that the steam is at sufficient temperature to effectively sterilize the items. **Remember: 15 pounds for at least 15 minutes.**
7. The steam will build up in the inside of the pressure cooker until it reaches the correct pressure. At this point, the steam will lift the weight and start to escape. As soon as the steam starts to escape, start timing the sterilization and turn down the heat so that the steam is only just escaping and not rushing out. Aim to maintain a gentle hissing.
8. After 20 minutes turn off the heat and leave to cool. (The microbiology books say 15 minutes is sufficient at 15 pounds pressure to kill all spores, so this is just a bit of conservative extra heat/time.
9. Wait until pressure is completely reduced then lift the weight off the valve allowing any remaining steam to escape. Never open the pressure cooker until the steam valve has been opened to release the pressure. Open the pressure cooker carefully using the metal lid to shield yourself. The contents will still be very hot so allow them to cool for 10-15 minutes before handling.
10. Set sterile wrapped items to dry unless you need to use them immediately.
11. CAUTION ! If anything in the load has paper or cloth wrappings, don't allow them to touch anything unsterile, until they have dried, because microbes can penetrate wet paper. ALWAYS VENT BOTTLES TO PREVENT

BURSTING. Again, instruments can be used as soon as they are cool enough to handle.

Instruments can be placed in instrument boxes or wrapped in linen/towels during sterilization. Generally wrapped instruments can be stored for about 30 days.



Instrument trays available at Amazon.



Surgical towels are reusable and available at Amazon. These may be available as part of unused and expired suture kits and are often discarded unused.

Linens may be autoclaved/sterilized. Ensure that you wrap the linens in an outer wrapper/cover so that they stay sterile while drying.

Although these instructions “should” be more than sufficient to sterilize medical instruments, a double check with sterilization indicator tape is a good idea. The tape has stripes that change color when the desired temperature has been reached for a specified time. Available at Amazon:



Sterilization indicator tape is also available from Amazon.

Dry-Heat Sterilization

Dry heat was first used by Louis Pasteur to sterilize items in his lab. Dry heat is a very viable method of sterilization. The dry-heat sterilization process works via conduction whereby heat is absorbed by the exterior surfaces of an item and then gradually passes throughout it so that eventually the entire object reaches the proper temperature required to achieve sterilization. Air is a poor conductor of heat and consequently, the times needed for sterilization here are much longer than for autoclaving.

Dry heat is most suitable for metal objects and glassware. It can also be used for oils or powders that can't get wet. Items to be sterilized must be perfectly dry before placing them in the oven to avoid breakage. Articles should be spaced with sufficient distance to allow free circulation of air. Mouths of flasks, test tubes and pipettes should be plugged with cotton wool. Articles such as pipettes can be wrapped in kraft paper or aluminum foil.

Effective time and temperature and temperature combinations for dry-heat sterilization are **160°C (320°F) for 2 hours** or **170°C (340°F) for 1 hour**. Be sure to use an oven thermometer for accuracy in the sterilization process. Increasing the temperature by 10 degrees shortens the sterilization time by 50%. The hot air oven should not be opened until the temperature has fallen to 60°C to avoid glass breakage.

A conventional convection household oven is ideal for this process, but any oven can be used. The convection oven is better because the fan circulates hot air to ensure an even heat throughout the oven.

This method is usually used for materials which can withstand the high temperatures, such as metal and glass, and for those which could either be corroded by steam or must remain dry. Again materials can be wrapped in linens to maintain sterility after treatment.

Sterilization Shelf Life of Packaged Supplies

The following wrapped items, if carefully maintained and kept clean and dry, are sterile for up to one (1) month:

Double cloth wrapped instruments

Double paper wrapped instruments

Inexpensive peel pouches for gauze sponges

Sterility Maintenance Covers -- Sealable plastic covers placed over freshly autoclaved and cooled packs to extend shelf life by diminishing air penetration and are sterile for up to six (6) months:

Table

The Relationship Between the Pressure and Temperature of Steam at Sea Level		
Pressure	Temp C	Temp F
0	100	212
5	110	230
10	116	240.8
15	121	249.8
20	126	258.8
30	135	275

References for this paper are available on request.