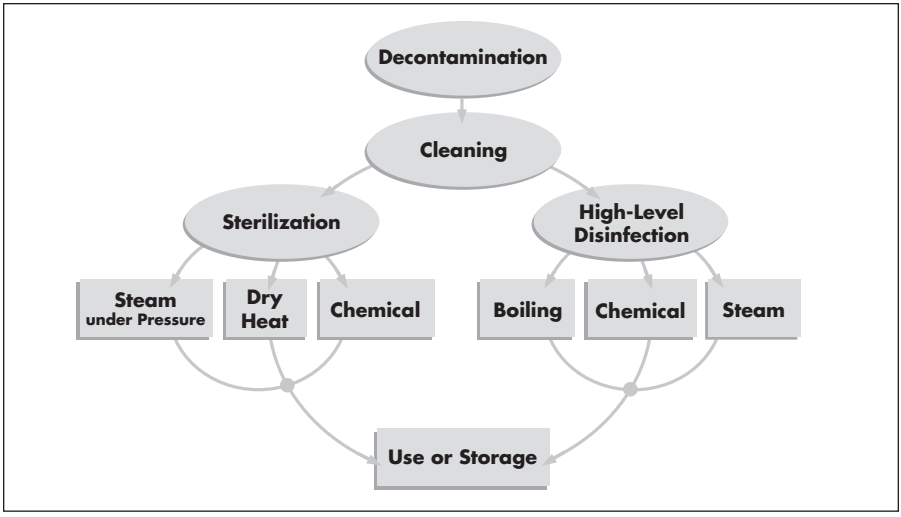
Instrument Processing

Proper processing is critical for reducing infection transmission during clinical or surgical procedures. Correct handling and processing also reduces staff's risk of infection.

The steps of processing

There are four steps to processing instruments and other items used during clinical and surgical procedures: decontamination, cleaning, sterilization or high-level disinfection (HLD), and use or storage.



Step 1 Decontamination

The first step in processing instruments and other items for reuse, decontamination kills viruses (such as hepatitis B, other hepatitis viruses, and HIV) and many other microorganisms, making items safer to handle by the staff who perform cleaning and further processing. Decontamination makes items easier to clean by preventing blood, other body fluids, and tissue from drying on them. Cleaning is still necessary, however, since decontamination does not remove all of the body fluid, tissue, or dirt on the items.

It is important for staff to know how to decontaminate items, to know that they should place items in the decontamination bucket without splashing the solution, and to know that they should always rinse their gloves in a decontamination solution before removing them.

To decontaminate items, use a 0.5% chlorine solution or a solution made from another acceptable disinfectant. (Because chlorine is usually the cheapest, most universally available disinfectant, this booklet will focus on the use of a 0.5% chlorine solution.)

How to make a 0.5% chlorine solution

A solution that is too weak (less than 0.5% active chlorine) may not adequately kill microorganisms during the recommended time for soaking. A solution that is too strong (more than 0.5% active chlorine) may increase the cost of supplies by using more bleach than necessary and may damage instruments, other items, and environmental surfaces.

Because of their low cost and wide availability, chlorine solutions prepared from liquid or powdered bleach are recommended. A chlorine solution can be made from:

1. **Liquid household bleach.** (Sodium hypochlorite)
2. **Bleach powder.** Chlorine compounds available in powder form (calcium hypochlorite or chlorinated lime)
3. **Chlorine-releasing tablets.** (Sodium dichloroisocyanurate)

About Chlorine

Chlorine is one of the oldest and most common compounds used as a disinfectant because:

- **It is a proven and powerful killer of microorganisms.**
- **It deodorizes.**
- **It is not poisonous to humans in the concentrations in which it is used.**
- **It leaves no poisonous residue.**
- **It is colorless, easy to handle, and economical to use.**

Chlorine-containing compounds are described as having a certain percentage of "active" (or available) chlorine. It is the active chlorine in these products that kills microorganisms. The amount of active chlorine is usually described as a percentage, and differs from one product to another. This is important so that a chlorine solution with 0.5% "active" chlorine can be prepared.

Note: In countries where French products are available, the amount of active chlorine is usually expressed in "degrees chlorum." One degree chlorum is equivalent to 0.3% active chlorine.

1. Using liquid household bleach

Chlorine in bleach comes in different concentrations. You can use any type of bleach, no matter what the concentration, to make a 0.5% chlorine solution by using the following formula:

[% active chlorine in liquid bleach ÷ 0.5%] - 1 = parts of water for each part bleach

Note that "parts" can be used for any unit of measure (e.g., ounce, liter, or gallon) and need not even represent a defined unit of measure (e.g., a pitcher or container may be used).

Example: To make a 0.5% chlorine solution from bleach with 3.5% active chlorine, you must use 1 part bleach and 6 parts water:

[3.5% ÷ 0.5%] - 1 = [7] - 1 = 6 parts water for each part bleach

2. Using bleach powder

If using bleach powder, calculate the ratio of bleach to water using the following formula:

[0.5% ÷ % active chlorine in bleach powder] x 1000 = grams of powder for each liter of water

Example: To make a 0.5% chlorine solution from calcium hypochlorite powder containing 35% available chlorine:

[0.5% ÷ 35%] x 1000 = [0.0143] x 1000 = 14.3 grams

Therefore, you must dissolve 14.3 grams of calcium hypochlorite powder in 1 liter of water in order to get a 0.5% chlorine solution.

Note that when bleach powder is used, the resulting chlorine solution is likely to be cloudy (milky).

3. Using chlorine-releasing tablets

Follow the manufacturer's instructions, since the percentage of active chlorine in these products varies. If the instructions are not available with the tablets from your supply source, ask for the product's instruction sheet or contact the manufacturer.

Steps of Decontamination

Step 1

Immediately after use, decontaminate instruments and other items by placing them in a plastic container of 0.5% chlorine solution. Let them soak for 10 minutes. A container of this solution should be kept in every operating theater and procedure room so that used items can be placed directly into the bucket. Service providers should put instruments and other items in the chlorine solution as soon as they are finished using each item.

Step 2

After 10 minutes, remove the items from the chlorine solution and either rinse with water or clean immediately. Do not leave items in the solution for more than 10 minutes, since excessive soaking in the solution can damage instruments and other items. Always wear utility gloves when removing instruments and other items from a chlorine solution.

It may be useful to set up a bucket of tap water next to the bucket of decontamination solution. This way, when the items are ready to be removed from the decontamination solution, they can be placed in the water until the appropriate staff member is ready to clean them.

Items that require special consideration:

- **Reusable needles and syringes:** Fill the assembled needles and syringes with a 0.5% chlorine solution, flush several times (draw up and expel the 0.5% chlorine solution into and out of the syringe), and soak for 10 minutes. Rinse by flushing several times with clean water or clean immediately. Always use pickups and wear utility gloves when removing needles and syringes from the solution. *(For more information on the proper handling of these items, see pages 20–24.)*
- **Gloves:** Before removing contaminated gloves, dip gloved hands into a 0.5% chlorine solution to rinse the outer surfaces and remove blood, other fluids, and tissue. Carefully remove gloves without touching the outer surface with bare hands. Do not snap the gloves. If the gloves are disposable or are not intact, dispose of them properly. If they are surgical gloves that will be processed for reuse, place them in a container of 0.5% chlorine solution and soak for 10 minutes before cleaning. Rinse or clean immediately. To avoid tearing or puncturing gloves during decontamination, place them in a different container than the one used to decontaminate instruments and other items.

- **Linens (caps, gowns, masks, and surgical drapes):** Decontamination of linens is impractical and is not recommended. Handle, transport, and process linens that are soiled with blood, other body fluids, secretions, and excretions in a way that prevents exposure to skin and mucous membranes, contamination of clothing, and transfer of microorganisms to clients or the environment. When transporting linens to washing areas, place the linens in leakproof containers or fold them so that the portions that are contaminated are on the inside, surrounded by dry linen. Always wear heavy utility gloves when handling, transporting, and processing used linens, and wash hands immediately after removing gloves. If linen will be processed outside of the facility, make sure that the person who transports them to the processing site wears utility gloves.
- **Storage containers:** Fill containers with a 0.5% chlorine solution and soak for 10 minutes before cleaning. Rinse or clean immediately.
- **Laparoscopes:** There is no effective way to decontaminate laparoscopes and cables. They cannot be soaked in chlorine solution, since chlorine can damage the laparoscope and cable. In addition, alcohol should not be used, as it can fog the lens or dissolve the cement holding the lens in place. When handling laparoscopes, always wear utility gloves.
- **Instruments used during manual vacuum aspiration (MVA):** Leave the cannula attached to the syringe and flush the syringe with a 0.5% chlorine solution one or two times. This will help remove any blood and tissue remaining in the cannula. Drop the assembled cannula and syringe into the 0.5% chlorine solution and soak for 10 minutes before cleaning. Rinse by flushing the assembled cannula and syringe three times with clean water, or clean immediately.

Step 2 Cleaning

While decontamination makes items safer to handle, cleaning, the second step in processing, removes organic material, dirt, and foreign matter that can interfere with sterilization or HLD. Cleaning also drastically reduces the number of microorganisms, including bacterial endospores, on instruments and other items.

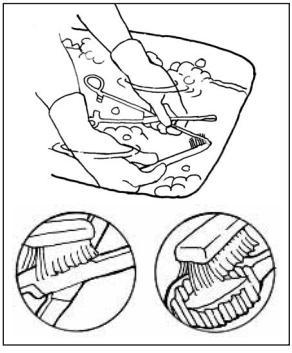
Cleaning refers to scrubbing with a brush, detergent, and water and is a crucial step in processing. Without cleaning, further processing might not be effective because:

- Microorganisms trapped in organic material may be protected and survive further processing.
- Organic material and dirt can make the chemicals used in some processing techniques less effective.

Detergent is important for effective cleaning, because water alone will not remove protein, oils, and grease. When detergent is dissolved in water, it breaks up and dissolves or suspends grease, oil, and other foreign matter, making them easy to remove. Do not use hand soap for cleaning instruments and other items, because the fatty acids contained in the soap will react with the minerals of hard water, leaving a residue or scum that is difficult to remove.

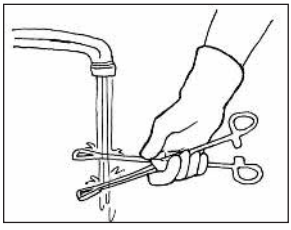
Steps of Cleaning

Always wear utility gloves, a mask, and protective eyewear when cleaning instruments and other items. Avoid using steel wool or abrasive cleansers such as Vim or Comet. These products can scratch or pit metal or stainless steel, resulting in grooves that can become a nesting place for microorganisms. This also increases the potential for corrosion of the instruments and other items.



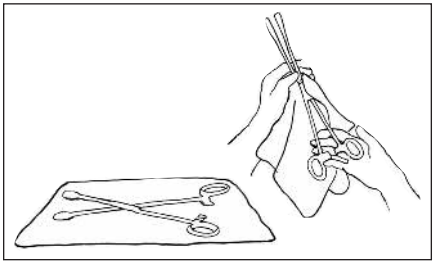
Step 1

Using a soft brush or old toothbrush, detergent, and water, scrub instruments and other items vigorously to completely remove all blood, other body fluids, tissue, and other foreign matter. Hold items under the surface of the water while scrubbing and cleaning to avoid splashing. Disassemble instruments and other items with multiple parts, and be sure to brush in the grooves, teeth, and joints of items where organic material can collect and stick.



Step 2

Rinse items thoroughly with clean water to remove all detergent. Any detergent left on the items can reduce the effectiveness of further chemical processing.



Step 3

Allow items to air-dry (or dry them with a clean towel).

Note: Instruments that will be further processed with chemical solutions must dry completely to avoid diluting the chemicals; items that will be high-level disinfected by boiling or steaming do not need to be dried first.

Items that require special consideration:

- **Reusable needles and syringes:** Disassemble the needle and syringe, then wash with detergent and warm water to remove all particles. If a stylet or wire is available, insert it through the needle to make sure the needle is not clogged. Reassemble and rinse with clean water by flushing with water (drawing in and expelling the water) at least three times. Detach the needle and inspect it to make sure the hub area is clean, the needle is not bent, and the tip is not damaged. Check the syringe to make sure the seal is good and the markings are readable. Air-dry needles; air- or towel-dry syringes.
- **Surgical gloves:** To avoid tearing gloves, handle with care: do not scrub with a brush, and always wash gloves separately from other items. Wash gloves with detergent and warm water, and rinse them in clean water until all detergent is gone. Check for holes by inflating the gloves with air and holding them underwater (air bubbles will appear if there are holes), or fill the gloves with water and check for leaks. Towel-dry inside and out, or air-dry by hanging gloves in an area of low activity.
- **Linens (caps, gowns, masks, and surgical drapes):** Wash with detergent and hot water and rinse with clean water. Air- or machine-dry. To reduce the risk of exposure to infectious material, machine washing is recommended. When machine washing is not possible, staff who wash linens by hand should wear protective gear, such as utility gloves, waterproof aprons, and either faceshields or eyecovers and a mask to reduce the likelihood of exposure to blood and other body fluids.
- **Instruments used during MVA:** Disassemble the syringe completely (including removing the collar stop and the O-ring on the plunger. On a double-valve syringe, also remove the O-ring from inside the valve). Wash the parts of the syringe and the cannula with detergent and water. Scrub the syringe with a soft brush (e.g., a toothbrush). Do not use brushes or other objects to try to remove blood or tissue from the inside of the tip of the cannula; this may cause scratches that can trap materials and microorganisms or may damage the tip, increasing the risk of breakage. Instead, try to dislodge material in the tip by flushing the cannula with water (drawing up and expelling water) or flicking the top of the cannula with your gloved fingertips. Rinse with clean water and air-dry (drying is not necessary if the cannula will be further processed by boiling or steaming). Dry the syringe thoroughly before reassembling it.

Step 3 Sterilization or HLD

Sterilization ensures that items are free of all microorganisms (bacteria, viruses, fungi, and parasites), including bacterial endospores, that can cause infections in clients. Because sterilization kills all microorganisms, it is recommended for items like needles and surgical instruments that come in contact with the bloodstream or tissues under the skin. When sterilization is not available, HLD is the only acceptable alternative for these items.

Using sterilization

The effectiveness of any method of sterilization depends on the amount and type of microorganisms, organic material (blood, other fluids, tissues), and other matter (such as dirt) present on the item and the amount of protection the item gives the microorganisms (such as whether the item has grooves or other areas in which microorganisms can hide). Therefore, it is important to thoroughly clean instruments and other items before sterilization:

- To reduce the number of microorganisms
- To eliminate fluids or tissue remains
- To remove contaminants that can collect in joints, grooves, and teeth of items

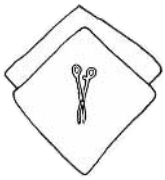
There are three methods of sterilization: steam sterilization (also known as "autoclaving" or "moist heat under pressure"), dry-heat sterilization (electric oven), and chemical ("cold") sterilization. You should have more than one method of sterilization or HLD available to use as a backup for when your equipment breaks down, supplies run low, or electricity is unavailable.

Note: Boiling is *not* a method of sterilization.

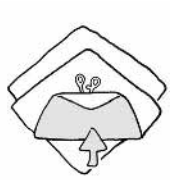
Wrapping items before sterilization

Wrapping items before steam and dry-heat sterilization helps decrease the likelihood that sterilized items will be contaminated before use. Under optimal storage conditions and with minimal handling, properly wrapped items can be considered sterile as long as they remain intact and dry. To wrap items for steam sterilization, use two layers of paper, newsprint, or muslin or cotton fabric. Do not use canvas for steam sterilization, since steam may not penetrate this material. When wrapping items for dry-heat sterilization, use foil, double-layered cotton, or muslin fabric.

Steps of Wrapping Items for Sterilization

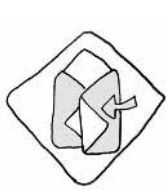


Step 1
Place the instrument or other item in the center of the top wrapper. The wrapper should be positioned so that the points —not the flat edges— are at the top, bottom, and sides.

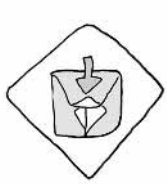


Step 2
Fold the bottom section of the *top* wrapper to the center, and fold back the point.

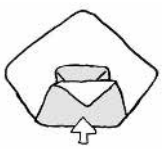
Step 3
Fold the left section to the center, and fold back the point.



Step 4
Fold the right section to the center, and fold back the point.

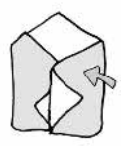


Step 5
Fold the top section to the center, and fold back the point.

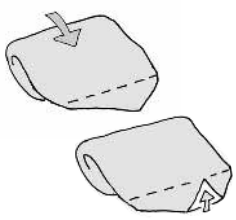


Step 6
Fold the bottom section of the *bottom* wrapper to the center, and fold back the point.

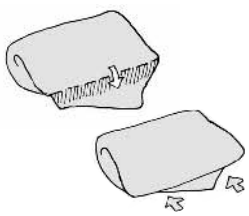
Step 7
Fold the left section to the center, and fold back the point.



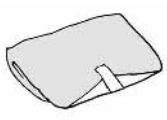
Step 8
Fold the right section to the center, and fold back the point.



Step 9
Fold the top section to the center, and fold back the point.



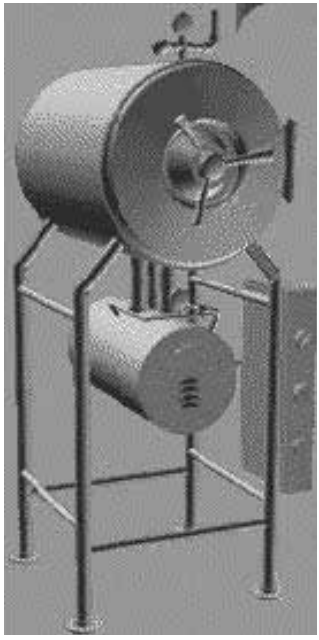
Step 10
Tuck the point under the right and left sections.



Step 11
Fasten the folds securely, using autoclave tape, if available.

1. Steam sterilization (autoclaving)

Steam sterilization in an autoclave is one of the most common forms of sterilization used in health care facilities. Steam sterilization requires moist heat under pressure, so there must be sources of both water and heat. Heat can be provided by electricity or by another fuel source (e.g., kerosene burner), depending on the type of autoclave being used.



It is important to know whether you are using an autoclave or a dry-heat oven, since different procedures are used with each. Remember that if you are using an autoclave, it must have a source of water (either the machine is hooked up directly to a water source or water is put into the machine before the cycle begins) and a pressure gauge.

Steps of Steam Sterilization

Step 1

Decontaminate, clean, and dry all instruments and other items to be sterilized.

Step 2

Open or unlock all jointed items, such as hemostats and scissors, and disassemble those with sliding or multiple parts. (This allows steam to reach all surfaces of the item.) Avoid arranging the items together tightly, because this prevents steam from reaching all surfaces.

Step 3

If items are to be wrapped before steam sterilization, use two layers of paper, newsprint, or cotton or muslin fabric (do not use canvas). Instruments and other items should not be placed in a closed container. If drums are being used, make sure the holes of the drum are open.

Step 4

Arrange all packs, drums, or unwrapped items in the chamber of the autoclave in a way that allows steam to circulate freely.

continued

Steps of steam sterilization continued

Step 5

Because there are many types of autoclaves, this booklet cannot provide specific instructions for each. Follow the manufacturer's instructions whenever possible. In general, sterilize wrapped items for 30 minutes and unwrapped items for 20 minutes at 121°C (250°F) and 106 kPa (15lb/in^2) pressure. (Do not begin timing until the autoclave reaches the desired temperature and pressure. If you forget to start timing the procedure, start timing at the point at which you realize this.)

Note: The units of pressure marked on an autoclave's pressure gauge may be different on different machines. The following amounts (which are approximately equivalent) are the desired pressure for autoclaving:

15 lb/in^2 (15 pounds per square inch)
106 kPa (106 kilopascals)
1 atm (1 atmosphere)
1 kgf/cm^2 (1 kilogram of force per square centimeter)
776 torr
1 bar
776 mm Hg (776 millimeters of mercury)

Step 6

If the autoclave is automatic, the heat will shut off and the pressure will begin to fall once the sterilization cycle is complete. If the autoclave is not automatic, turn off the heat or remove the autoclave from the heat source after 30 minutes if items are wrapped, 20 minutes if items are unwrapped. Wait until the pressure gauge reads "zero" to open the autoclave. Open the lid or door to allow the remaining steam to escape. Leave instrument packs or items in the autoclave until they dry completely (which could take up to 30 minutes).

Note: Items must be removed dry: damp packs will draw microorganisms from the environment and should be considered contaminated.

Step 7

Remove the packs, drums, or unwrapped items from the autoclave (use sterile pickups for handling unwrapped items). To prevent condensation, place packs or drums on a surface padded with paper or fabric until they are cool. Do not store packs, drums, or unwrapped items before they reach room temperature (which may take several hours).

Step 8

Store items properly as follows:

- *Wrapped items.* Under optimal storage conditions and with minimal handling, properly wrapped items can be considered sterile as long as they remain intact and dry. For optimal storage, place sterile packs in closed cabinets in areas that are not heavily trafficked, have moderate temperature, and are dry or of low humidity. When in doubt about the sterility of a pack, consider it contaminated and resterilize the items.
- *Unwrapped items.* Use unwrapped items immediately after removal from the autoclave or keep them in a covered, dry, sterile container for up to one week.

Pressure-cooker-type autoclaves

Pressure-cooker-type autoclaves are common (especially in rural areas) and often do not come with instructions. The following can be used as instructions:

- **Put water in the bottom of the autoclave (up to the ridge located on the inner wall).**
- **Place items in the autoclave and arrange them loosely, so that the steam can circulate around them.**
- **Place the autoclave over the heat source (e.g., electric stove, kerosene burner) and turn to high heat. Once steam is emitted from the pressure valve, begin timing the sterilization cycle. (For this type of autoclave, 20 minutes is suggested, regardless of whether items are wrapped or unwrapped.)**
- **Turn the heat down, but make sure that steam continues to come out of the pressure valve. This will reduce the amount of fuel used.**
- **After 20 minutes, remove the autoclave from the heat source, open the pressure valve to release the steam, and allow the autoclave to cool for 15–30 minutes before opening it.**

Each time you prepare to use the autoclave, check the gaskets, gauges, and pressure and safety valves for defects. Clean the chamber and cover regularly.

Autoclave maintenance

If you use steam sterilization at your facility, the autoclave should be checked each time it is used to make sure that it is functioning properly. If any repairs are necessary, they should be made before the autoclave is used again. If the autoclave is faulty, sterilization will not be achieved. The autoclave is not working correctly:

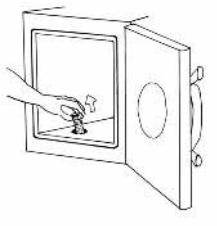
- If steam comes out of the safety valve instead of the pressure valve. If this happens, the pressure valve must be cleaned and inspected.
- If steam comes out from under the lid or around the door. If this happens, the gasket must be cleaned and dried or replaced.

Routine maintenance should become standard procedure. (Follow the manufacturer's instructions whenever possible, since autoclave maintenance varies depending on the type of autoclave used.)

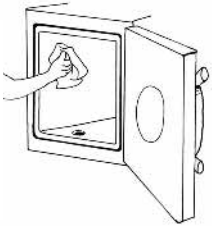
General Guidelines for Routine Maintenance that Are Likely to Apply to Many Autoclaves

Daily

- Remove the outlet screen, and clean with detergent and a brush under running water.



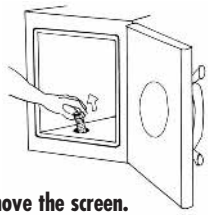
- Clean the chamber using a cloth. Do *not* use abrasive cleansers or steel wool; they will scratch the surface and increase corrosion.



- Clean the door or lid gaskets with a cloth and check for defects. Replace defective gaskets.
- Clean the shelves in the autoclave or the basket or cart that holds packs (including the wheels of the cart) with detergent and a cloth.

Weekly

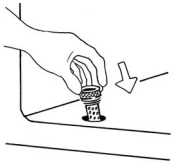
Check the manufacturer's instructions for maintenance of the exhaust line. If the instructions are unavailable, flush the exhaust line or chamber drain to keep it free of material that may interfere with air and steam leaving the chamber, as follows:



1 Remove the screen.

2 Pour 1 liter of detergent and hot water solution down the drain with a funnel.

3 Pour 1 liter of hot water down the drain to rinse out the detergent solution.



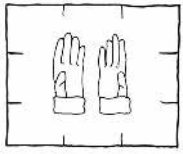
4 Replace the screen.

Steam sterilization of surgical gloves

Gloves may be powdered before steam sterilization to prevent them from sticking together and to make them easier to put on. However, powder has been shown to lead to inflammatory reactions in clients (with subsequent granuloma or adhesion formation) and may cause increased development of latex allergies or dermatitis in health care workers. If powder is used, use only absorbable powders, such as starch. (Do not use talcum powder, which is nonabsorbable.) To reduce the risk of inflammatory reactions in clients, staff should rinse gloved hands with sterile water or saline solution after putting on powdered gloves and before handling instruments or performing a clinical procedure.

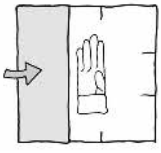
Wrapping gloves before steam sterilization helps decrease the likelihood that they will become contaminated before use. Use paper, newsprint, or muslin or cotton fabric. Do not use canvas. Wrap gloves with a cuff so that they can be easily put on without contaminating them. Do not roll gloves into balls before sterilization (this makes it difficult for steam to reach all surfaces of the gloves, making sterilization ineffective).

Steps of Wrapping Gloves for Steam Sterilization



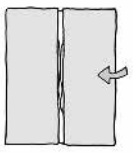
Step 1

Place one pair of gloves in the center of the wrapper. The wrapper should be positioned so that the flat edges—not the points—are at the top, bottom, and sides.



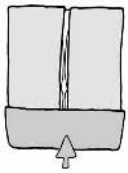
Step 2

Fold the left section to the center.



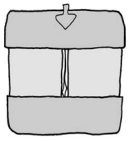
Step 3

Fold the right section to the center.



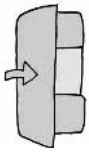
Step 4

Fold the bottom section halfway to the center (one-quarter of the way up).



Step 5

Fold the top section halfway to the center (one-quarter of the way down).



Step 6

Fold the packet in half vertically, either from left to right or from right to left.

Step 7

Mark on the outside of the wrapper the end at which the gloves' cuffs are positioned. (This will help ensure that the gloves will be in the correct position when the provider opens the pack to put them on.)

2. Dry-heat sterilization (electric oven)

Dry-heat sterilization requires high heat for a specific period of time. For sterilization to be achieved, a constant supply of electricity is necessary. Because of the high temperatures, only glass or metal objects can be sterilized by dry heat. Do not use this method for other items, such as surgical gloves, which may melt or burn.

It is important to know whether you are using an autoclave (steam sterilizer) or a dry-heat oven, since different procedures are used with each. Remember that a dry-heat oven does not use water or have pressure gauges.

Steps of Dry-Heat Sterilization

Step 1

Decontaminate, clean, and dry all items to be sterilized.

Step 2

Either 1) wrap the items using foil, double-layered cotton, or muslin fabric; 2) put unwrapped items on a tray or shelf; or 3) place items in a metal, lidded container.

Note: **Because dry-heat sterilization works by raising the temperature of the entire item to the designated temperature, it is not necessary to open or unlock hinged instruments or other items or to disassemble those with sliding or multiple parts. In addition, instruments and other items can be placed in closed containers.**

Step 3

Place items in the oven and heat to the correct temperature (the oven must contain a thermometer or temperature gauge). Use the following list to determine the time required to sterilize items at different temperatures. Do not begin timing until the oven reaches the desired temperature, and do not open the oven once timing has begun. (Use a timer or make sure to record the time.) If you forget to start timing the procedure, start timing at the point at which you realize this.

Temperature	Time
170°C (340°F)	1 hour
160°C (320°F)	2 hours
150°C (300°F)	2.5 hours
140°C (285°F)	3 hours

Note: **This list shows the amount of time that items must be kept at the desired temperature to ensure that sterilization is achieved. Keep in mind that the total cycle time—including heating the oven to the correct temperature, sterilization, and cooling—is usually twice as long as the time noted here. Because dry heat can dull sharp instruments and needles, these items should not be sterilized at temperatures higher than 160°C.**

Step 4

Leave items in the oven to cool. When they are cool, remove items and use or store immediately. (Use sterile pickups to remove unwrapped items.)

continued on page 40

Steps of dry-heat sterilization continued

Step 5

Store items properly, as follows:

- ***Wrapped items.*** **Under optimal storage conditions and with minimal handling, properly wrapped items can be considered sterile as long as they remain intact and dry. For optimal storage, place sterile packs in closed cabinets in areas that are not heavily trafficked, have a moderate temperature, and are dry or of low humidity. When in doubt about the sterility of a pack, consider it contaminated and resterilize the items.**
- ***Unwrapped items.*** **Use unwrapped items immediately after removal from the oven or keep them in a covered, dry, sterile container for up to one week.**

Maintenance of ovens

If you use dry-heat sterilization at your facility, routine maintenance is important to ensure that the oven is functioning properly. If the oven does not reach the correct temperature, sterilization will not be achieved. Be sure to:

- Keep the oven clean.
- Check that the temperature gauge is working correctly on a regular basis—every few weeks is sufficient—by putting a thermometer in the oven and comparing the temperature reading with the one on the gauge.

3. Chemical ("cold") sterilization

Chemical sterilization is used for items that are heat sensitive or when methods that require heat are unavailable. Items are sterilized by soaking them in an appropriate chemical solution (such as one containing glutaraldehyde) and rinsing them in sterile water.

Cidex, which contains glutaraldehyde, is a commonly available solution used for sterilization. Other products containing glutaraldehyde or other chemical sterilants may be locally available, but you should make sure that the solution you want to use is appropriate for sterilization. Remember that:

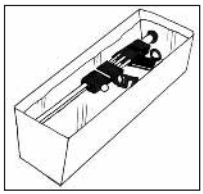
- Glutaraldehyde is irritating to the skin, eyes, and respiratory tract. When using it, wear gloves, limit your exposure time, and keep the area well ventilated.
- The length of time that commercially available glutaraldehyde solutions can be used varies, usually from 14–30 days. Always follow the manufacturer's instructions regarding proper storage temperatures and expiration date. Solutions should be replaced anytime they become cloudy.
- Formaldehyde is potentially cancer causing and extremely irritating to the skin, eyes, nose, and respiratory tract. Therefore, routine use of formaldehyde for sterilizing instruments and other items is *not* recommended.

Steps of Chemical Sterilization

Step 1

Decontaminate, clean, and thoroughly dry all instruments and other items to be sterilized. Water from wet instruments and other items dilutes the chemical solution, thereby reducing its effectiveness.

Step 2



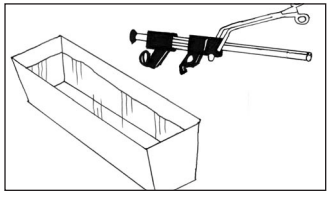
Prepare the glutaraldehyde or other chemical solution by following the manufacturer's instructions or use a solution that was prepared previously, as long as it is clear (not cloudy) and has not expired. (Most commercially available glutaraldehyde solutions can be used for at least two weeks after preparation; follow the manufacturer's instructions. Ideally, an indicator strip should be used each time the solution is to be used to determine if the solution is still effective.) After preparing the solution, put it in a clean container with a lid. Always mark the container with the date the solution was prepared and the date it expires.

Step 3

Open all hinged instruments and other items and disassemble those with sliding or multiple parts; the solution must contact all surfaces in order for sterilization to be achieved. Completely submerge all instruments and other items in the solution; all parts of the instruments and other items should be under the surface of the solution. Place any bowls and containers upright, not upside down, and fill with the solution.

Step 4

Follow the manufacturer's instructions regarding the time necessary for sterilization to be achieved. In general, if the solution contains glutaraldehyde, cover the container, and allow the instruments and other items to soak for at least 10 hours. Do not add or remove any instruments or other items once timing has begun.



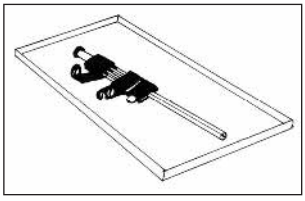
Step 5

Remove the instruments and other items from the solution using large, sterile pickups (lifters, cheatle forceps).

Step 6

Rinse thoroughly with sterile water to remove the residue that chemical sterilants leave on instruments and other items; this residue is toxic to skin and tissues. *Note:* Boiled water is not sterile, because boiling does not guarantee that bacterial endospores have been killed. Therefore, rinsing with boiled water can contaminate sterilized instruments and other items.

Step 7



Proper storage is as important as the sterilization process itself. Place the instruments and other items on a sterile tray or in a sterile container and allow to air-dry before use or storage. Use the instruments and other items immediately or keep in a covered, dry, sterile container and use within one week.

Monitoring the effectiveness of sterilization

There are three ways to monitor the effectiveness of sterilization:

1. **Mechanical indicators.** These indicators, which are part of the sterilization equipment (the autoclave or dry-heat oven), record and allow you to observe time, temperature, and/or pressure readings during the sterilization cycle.

2. **Chemical indicators.** These include:
   - Tape with lines that change color when the intended temperature is reached
   - Pellets in glass tubes that melt, indicating that the intended temperature and time have been reached
   - Indicator strips that show that the intended combination of temperature, time (and, in an autoclave, steam) has been achieved
   - Indicator strips that show that sterilization chemicals are still effective

3. **Biological indicators.** These indicators use heat-resistant bacterial endospores to demonstrate whether or not sterilization has been achieved. (If the bacterial endospores have been killed after sterilization, you can assume that all other microorganisms have been killed as well.) The advantage of this method is that it directly measures the effectiveness of sterilization. The disadvantage is that this indicator is not immediate, as are mechanical and chemical indicators. Bacterial culture results are needed before sterilization effectiveness can be determined.

Recommended monitoring system:

- Record all information (temperature, time, pressure, or all three, depending on the method being used) in a log each time you perform sterilization, and review the log after each load. (Some sterilization equipment has a built-in recording chart that will do this for you.)
- For methods that require heat or steam, place heat- and steam-sensitive indicators on the inside and outside of each pack.
- Perform testing with biological indicators weekly (or monthly, if testing weekly is not possible).
- If using chemicals, use an indicator strip to determine whether the solution is still effective before performing sterilization and replace the solution if necessary.

In case of failure:

If monitoring indicates a failure in sterilization, immediately attempt to determine the cause of the failure. First, check that equipment is being used correctly. If correct use of equipment has been documented and monitoring still indicates a failure in sterilization, discontinue use of the equipment and have it serviced. Any items processed in the faulty equipment should be considered nonsterile and must be processed again when the equipment is functioning.

Special considerations

Special considerations must be taken when sterilizing liquids, gloves, reusable needles and syringes, linens, and the instruments used during manual vacuum aspiration.

Liquids

Liquids (such as water used to rinse items after chemical sterilization) can be sterilized only by steam sterilization, not by dry-heat or chemical sterilization. Special procedures must be followed to safely and properly sterilize liquids.

Liquids must be sterilized separately from other items, such as instruments or linens. Place liquids in heat-resistant glass (e.g., Pyrex) bottles with self-sealing caps, and autoclave them at the same temperature and pressure used for other items. The time necessary to autoclave liquids depends on many factors, the most important of which is the volume of liquid being autoclaved. In general:

75–100 mL = 20 minutes
250–500 mL = 25 minutes
1000 mL = 30 minutes
1500 mL = 35 minutes
2000 mL = 40 minutes

Once sterilization is complete, the chamber pressure must be released slowly—over a period of at least 10–15 minutes. Rapid release will cause liquids to boil violently, which may cause the caps to blow off or the bottles to burst. Open the autoclave door slightly and allow liquids to cool for approximately 30 minutes before removal.

Surgical gloves

Whenever possible, use disposable surgical gloves that arrive from the manufacturer in a sterile package and are thrown away after one use. Gloves are difficult to process, and processing may make gloves brittle or introduce tiny tears or holes. When surgical gloves must be processed, steam sterilization must be used. Gloves will melt in dry-heat ovens, and chemical sterilization is impractical because of the difficulty in rinsing off chemical residue. If possible, wrap gloves before sterilization (see page 38).

Reusable needles and syringes

Whenever possible, use disposable needles and syringes, since these items are difficult to process correctly. If these items must be reprocessed, use the following instructions. (**Note:** Chemical sterilization is not recommended, since it is difficult to adequately rinse off chemical residue, which may interact with or inactivate the solution being injected).

- **For steam sterilization:** Flush needles with boiled water just before wrapping. (A small amount of water is needed to steam-sterilize items with lumens or small openings.)
- **For dry-heat sterilization:** Because high temperatures can dull sharp edges, reusable needles should not be sterilized at temperatures higher than 160˚C (320˚F). Plastic syringes will melt at this temperature and should not be processed with dry heat.

Linens (gowns and surgical drapes)
Only steam sterilization should be used for these items. Many fabrics burn at the high temperatures used for dry heat, and the quantity of sterile water that would be needed and the high risk of contamination during drying make chemical sterilization impractical. Packs containing gowns, drapes, and other linens should not be more than 30 x 30 x 50 cm (12 x 12 x 20 in.) or 5 kg (12 lb.) to allow steam to penetrate the items adequately. Place packs containing linens on their sides to make it easier for the steam to penetrate. (It is easier for steam to go through folds than through flat, compressed surfaces.)

Instruments used during MVA
It is best to chemically sterilize the cannula, but sterilization of the syringe after decontamination and proper cleaning is not necessary (it does not come in contact with the client and is used only as a source of vacuum and as a receptacle for blood and tissue). Sterilization may decrease the life of the syringe, since sterilization damages the syringe over time. If your facility requires sterilization of the syringe, it may be sterilized using chemicals. (Neither the cannula nor the syringe can withstand steam or dry-heat sterilization: the syringe value will be destroyed, and the cannula will melt.)

Soak the cannula and syringe in a chemical solution such as glutaraldehyde. (If available, ethylene oxide gas may be used.) Be sure that all parts of the syringe are completely submerged and that the barrel is filled with the solution. Be sure that the cannula is completely submerged and filled with the solution.

Using high-level disinfection

HLD eliminates bacteria, viruses, fungi, and parasites, but does not reliably kill all bacterial endospores, which cause diseases such as tetanus and gas gangrene. Because sterilization kills all microorganisms, including bacterial endospores, it is preferable for instruments and other items that will come in contact with the bloodstream or tissues under the skin. When sterilization is not available or feasible, HLD is the only acceptable alternative to sterilization for these items. HLD is also suitable for items

that will come in contact with broken skin or intact mucous membranes.

Note: Flaming (holding an item in a flame) is not an effective method of HLD because it does not effectively kill all microorganisms.

The effectiveness of HLD depends on the amount and type of microorganisms, organic material (blood, other fluids, tissues), and other matter (such as dirt) present on the item and the amount of protection the item gives the microorganisms (such as whether the item has grooves or other areas in which microorganisms can hide). Therefore it is important to thoroughly clean instruments and other items before HLD:

- To reduce the number of microorganisms
- To eliminate fluids or tissue remains
- To remove contaminants that can collect in joints, grooves, and teeth of items.

There are three methods of HLD: boiling, chemical HLD, and steaming. You should have more than one method of sterilization or HLD available to use as a backup for when your equipment breaks down, supplies run low, or electricity is unavailable. Many facilities use a method of HLD as a backup to their primary method of sterilization.

1. HLD by boiling

Boiling is a simple method of HLD that can be performed in any location that has access to clean water and a heat source. Using this method, instruments and other items are placed in a pot or boiler and the water is heated to boiling for 20 minutes.

Note: A white, scaly deposit may be left on items that have been boiled frequently and on the pot or boiler itself. These are lime deposits caused by lime salts in the water. To minimize lime deposits:

- Add some vinegar to the water to remove deposits on the items or the inside of the boiler.
- Boil the water for 10 minutes to precipitate the lime (to make it come out of the water and settle on the bottom or sides of the boiler instead of on the items being boiled) before the items are added.
- Use the same water throughout the day, adding only enough to keep the items below the surface.
- Drain and clean out the boiler at the end of each day.

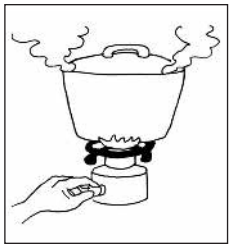
Steps of HLD by Boiling

Step 1
Decontaminate and clean all instruments and other items to be high-level disinfected.

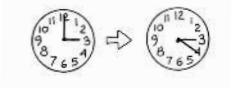
Step 2
Open all hinged instruments and other items and disassemble those with sliding or multiple parts. Place any bowls and containers upright, not upside-down, and fill with water. Because water must touch all surfaces for HLD to be achieved, completely submerge all instruments and other items in the water in the pot or boiler.

Step 3
Cover the pot or close the lid on the boiler and bring the water to a gentle, rolling boil.

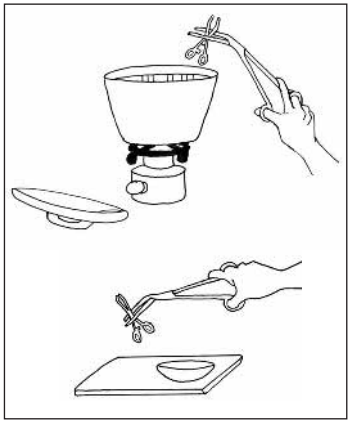
Step 4
When the water comes to a rolling boil, start timing for 20 minutes. Use a timer or make sure to record the time that boiling begins. From this point on, do not add or remove any additional water, instruments, or other items.



Step 5
Lower the heat to keep the water at a gentle, rolling boil; too vigorous a boil will cause the water to evaporate and may damage the instruments and other items if they bounce around the container and hit the sidewalls and other instruments or items. The lower heat also saves fuel/electricity.



Step 6
After 20 minutes, remove the instruments and other items using dry, high-level disinfected pickups (lifters, cheatle forceps). Place the instruments and other items on a high-level disinfected tray or in a high-level disinfected container, away from insects and dust and in a low-traffic area. Allow to air-dry before use or storage. Never leave boiled instruments and other items in water that has stopped boiling; they can become contaminated as the water cools down.



Step 7
Use instruments and other items immediately or keep in a covered, dry, high-level disinfected container and use within one week.

Tips for HLD by Boiling:

- ☛ **Items must be completely covered with water. Open all hinged instruments and disassemble items with sliding or multiple parts.**
- ☛ **Always boil for 20 minutes. Start timing when the water reaches a rolling boil.**
- ☛ **Do not add or remove anything once boiling begins.**

2. Chemical HLD

Chemical HLD is used for heat-sensitive items, like laparoscopes, or when a heat source is not available. Chemical HLD is different from chemical sterilization because:

- Either glutaraldehyde or chlorine may be used for HLD. (Chlorine cannot be used for sterilization.)
- The soaking time is shorter for HLD.
- HLD items may be rinsed with boiled water. (Sterilized items must be rinsed with *sterile* water.)

About Disinfectants

Disinfectants are used to kill microorganisms on inanimate objects; they should not be used on skin or mucous membranes. Disinfectants are used in three ways:

- **During decontamination: A disinfectant is used as the solution for decontamination.**
- **During chemical HLD and sterilization: Certain disinfectants can be used to sterilize or high-level disinfect instruments and other items.**
- **During housekeeping: Disinfectants are used to make the disinfectant cleaning solution used to clean high-risk areas.**

There are two types of disinfectants:

1. ***High-level disinfectants* are used for instrument processing. Some (such as glutaraldehyde) are chemical sterilants and, given sufficient time, will destroy bacterial endospores.**
2. ***Low-level disinfectants* are used for cleaning surfaces, such as floors and countertops. These should not be used for instrument processing. Low-level disinfectants, such as phenols (carbolic acid—e.g., Phenol, Lysol) and quaternary ammonium compounds (such as benzalkonium chloride—e.g., Zephiran), are suitable for cleaning, but most products have few advantages over using chlorine/detergent solutions, which are less expensive and often more readily available.**

Properties of chemicals used for HLD

In most settings, the only chemicals appropriate for HLD are chlorine and glutaraldehyde:

- *Chlorine* is available in liquid (sodium hypochlorite), powder (calcium hypochlorite or chlorinated lime), and tablet (sodium dichloroisocyanurate) form. Chlorine can be used for disinfection, decontamination (by soaking for 10 minutes), and HLD (by soaking for 20 minutes), but should not be used on endoscopic equipment. Because chlorine leaves a residue, rinse items thoroughly with boiled water after HLD. Chlor-ine can be corrosive to metals with prolonged contact and can be irritating to the skin, eyes, and respiratory tract. A new solution should be prepared daily (or whenever it becomes heavily contaminated).
- *Glutaraldehyde (e.g., Cidex)* is commonly used for processing equipment, such as laparoscopes, that cannot be heat sterilized. It can be used for HLD (by soaking for 20 minutes) and sterilization (by soaking for 10 hours*). Because glutaraldehyde leaves a residue, rinse items thoroughly with boiled water after HLD and with sterile water after sterilization. Glutaraldehyde can be irritating to the skin, eyes, and respiratory tract.

During HLD do *not* use:

- Hydrogen peroxide (6%), which has not been as well studied as other disinfectants. The 3% solution is suitable for disinfecting surfaces.
- Formaldehyde, which is potentially cancer causing and extremely irritating to the skin, eyes, and respiratory tract.
- Alcohol (60%–90% ethyl or isopropyl), which does not kill all viruses. However, alcohol can be used to disinfect thermometers and stethoscopes, although they should not remain soaking in an alcohol solution.
- Iodophors (e.g., Betadine), which are antiseptic preparations and not suitable for disinfection because of their low levels of iodine.
- Sporicidin, which is a glutaraldehyde-based product that has been shown to be ineffective.
- Carbolic acid (e.g., Lysol, Phenol), which is a low-level disinfectant.
- Chlorhexidine gluconate with cetrimide (e.g., Savlon), chlorhexidine gluconate (e.g., Hibitane, Hibiscrub), or chloroxylenol (e.g., Dettol), which are all antiseptics.

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* Note: Times apply to use of Cidex only; times for sterilization with other products may vary. Follow the manufacturer's instructions.

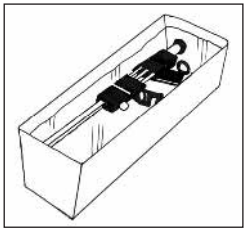
Steps of HLD Using Chemicals

Step 1

Decontaminate, clean, and thoroughly dry items. (Water from wet items dilutes the chemical solution, reducing its effectiveness.)

Step 2

When using glutaraldehyde: Prepare the solution as per the manufacturer's instructions or use a prepared solution, so long as it is clear (not cloudy) and has not expired. (Most glutaraldehyde solutions can be used for at least two weeks; follow the manufacturer's instructions. Ideally, use an indicator strip to determine whether the solution is effective.) After preparing the solution, put it in a clean container with a lid. Mark the container with the date the solution was prepared and the date it expires.



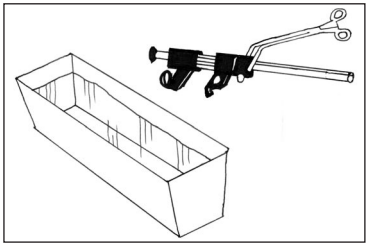
When using a chlorine solution: Follow the instructions on pages 26–27. Fresh solution should be made each day (or sooner, if the solution becomes dirty). Put the solution in a clean container with a lid.

Step 3

Open all hinged instruments and disassemble those with sliding or multiple parts (the solution must contact all surfaces in order for HLD to be achieved). Completely submerge all items so that all parts are under the surface. Place bowls and containers upright, not upside down, and fill with the solution.

Step 4

Cover the container, and allow the items to soak for 20 minutes. Do not add or remove items once timing has begun.

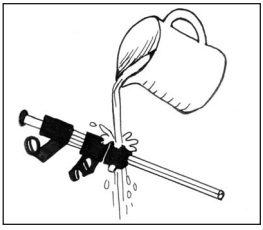


Step 5

Remove the items from the solution using dry, HLD pick-ups (lifters, cheatle forceps).

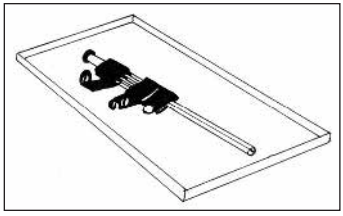
Step 6

Rinse thoroughly with boiled water to remove chemical residue, which is toxic to skin and tissues.



Step 7

Place the items on an HLD tray or in an HLD container and allow to air-dry before use or storage. Use items immediately or keep in a covered, dry, HLD container and use within one week.



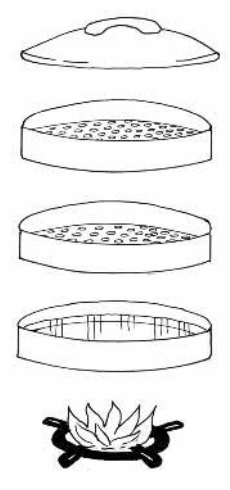
Tips for Chemical HLD:

- **Items must be completely covered with solution. Open all hinged instruments and disassemble items with sliding or multiple parts.**
- **Soak for 20 minutes. If you forget to start timing, start at the point at which you remember.**
- **Do not add or remove anything once timing begins.**
- **Rinse items thoroughly with boiled water.**

3. HLD by steaming

Items are steamed in a steamer containing one to three tiers. Steaming is the best method of HLD for gloves, and is a useful method of HLD for the cannulae used during manual vacuum aspiration. HLD of gloves by other methods is less appropriate because: 1) boiling is not recommended, since it is difficult to dry gloves properly without contaminating them. If it is necessary to HLD gloves by boiling, the gloves may be worn wet; 2) using chemicals is impractical since it is difficult to adequately rinse off the chemical residue. Whenever possible, use disposable gloves rather than reusable ones, since gloves are difficult to process.

Two-Tiered Steamer



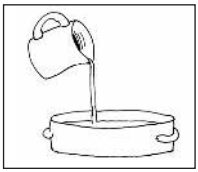
A tiered steamer, like the one shown here, can be used in a wide variety of settings.

Steps of HLD by Steaming

These steps should be followed for steaming gloves and MVA cannulae. Gloves are mentioned and shown in the illustrations as an example.

Step 1

Decontaminate and clean gloves to be high-level disinfected.

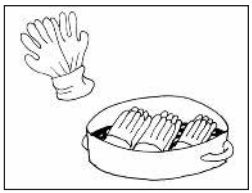


Step 2

Place water in the bottom tray (which has no holes).

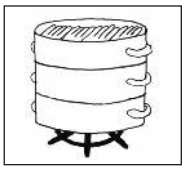
Step 3

Fold back the cuffs of the gloves in pairs and place the gloves in the tray(s) with holes. The number of gloves that will fit in each tray depends on the size of the tray (usually 5–15 pairs). If more than one layer of gloves is being steamed, loosely layer the gloves in a crisscross design. Gloves should not be packed tightly in the tray(s).



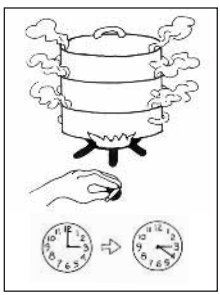
Step 4

Stack the tray(s) of gloves on top of the bottom tray.



Step 5

Place the lid on the top tray and bring the water to a boil. When steam comes out between the trays, the water is boiling. Reduce the heat, but maintain the water at a rolling boil (steam should continue to come out between the trays). High heat wastes fuel and causes the water to evaporate more quickly.

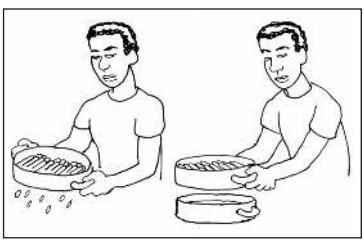


Step 6

Steam the gloves for 20 minutes. Use a timer or make sure to record the time.

Step 7

Remove each tray of gloves, shake off the excess water, and place the tray(s) on a second tray that does not have holes or contain water (a second bottom tray). (Do not place the tray containing the gloves directly on the countertop, since this may contaminate the gloves; remember, there are holes in the bottom of the tray.)



Step 8

Use the gloves immediately or allow them to dry for 4–6 hours (drying may be difficult in areas of high humidity).

Step 9

Store the gloves in a covered tray or put them in a high-level disinfected container and use within one week.

Special considerations

Special considerations must be taken when performing HLD on reusable needles and syringes, linens, and the instruments used during MVA.

Reusable needles and syringes

Whenever possible, use disposable needles and syringes rather than reusable ones, since these items are difficult to process correctly. Chemical HLD is not recommended for these items, since it is difficult to adequately rinse off the chemical residue, which may interact with or inactivate the solution being injected. Boiling is acceptable for these items.

Linens (gowns and surgical drapes)

HLD is impractical for these items; only steam sterilization should be used.

Instruments used during MVA

The cannula must be sterilized or high-level disinfected, but further processing of the syringe after decontamination and proper cleaning is not necessary because it does not come in contact with the client and is used only as a source of vacuum and as a receptacle for blood and tissue. Sterilization and HLD may actually decrease the life of the syringe, since these processes damage the syringe over time. If your facility requires processing of the syringe, use chemical HLD and be sure that the syringe is completely submerged and the barrel filled with the solution.

HLD through boiling, chemicals, or steaming may be used for the cannula. Research has shown that the cannula does not need to be submerged in the water for boiling to be effective; however, the boiler must be kept covered during processing.

Step 4 Storage

Items should be used or properly stored immediately after processing so that they do not become contaminated. Proper storage is as important as proper decontamination, cleaning, and sterilization or HLD. If items are not stored properly, all the effort and supplies used to properly process them will have been wasted, and the items may be contaminated.

Specific instructions for proper storage depend on whether sterilization or HLD has been performed, the method used, and whether the items are wrapped or unwrapped. (In this booklet, any method-specific instructions for storage have been noted as the last step in the sterilization or HLD process.)

Note: No matter what method is used, do not store instruments or other items (such as scalpel blades and suture needles) in solutions: always

store them dry. Microorganisms can live and multiply in both antiseptic and disinfectant solutions, and items left soaking in contaminated solutions can lead to infections in clients. In addition, antiseptic solutions should *not* be used to process objects.

Remember: If an item comes in contact with persons, surfaces, dust particles, insects, or any item that is not sterile or HLD, the item must be considered to be contaminated. Because of the high risk of contamination, unwrapped sterile or HLD items should be used immediately or kept in a covered, sterile or HLD container for no longer than one week after processing.

Storage of wrapped, sterile items

The length of time a wrapped, sterile item is considered sterile depends on whether or not a contaminating event occurs—not necessarily on how long the item has been stored. The shelf life of a wrapped item is affected by a number of factors, including:

- The type of packing material used
- The number of times the pack is handled
- The number of people who handle the pack
- The cleanliness, humidity, and temperature of the storage area
- Whether the packs are stored on open or closed shelves
- Whether dust covers (such as sealed plastic bags) are used

For optimal storage, place sterile packs in closed cabinets in areas that are not heavily trafficked, have moderate temperatures, and are dry or of low humidity. Under optimal storage conditions and with minimal handling, properly wrapped items can be considered sterile as long as they remain intact and dry.

Storage time and the handling of sterile packs should be kept to a minimum, since the likelihood of contamination increases over time and with increased handling. When in doubt about the sterility of a pack, consider it to be contaminated and resterilize the item before use.

Organizing an area for instrument processing

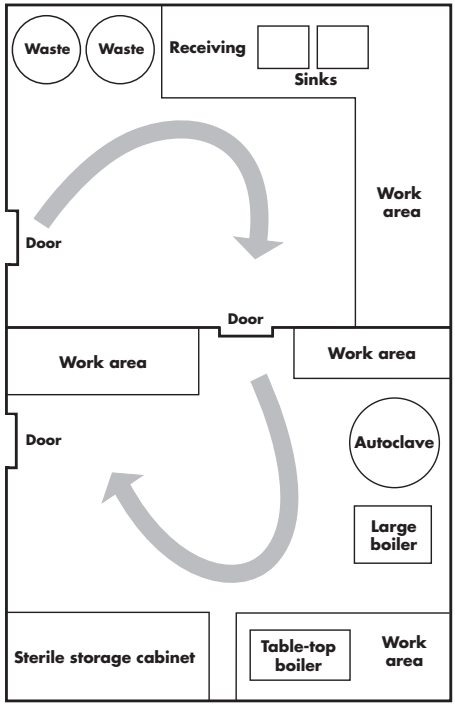
Remember, the objectives of processing are:

- To remove as many microorganisms as possible so that microorganisms are not transmitted to clients during clinical procedures
- To reduce the risk of infection to staff by eliminating harmful microorganisms on items that have been in contact with a client's fluids or tissues during clinical procedures

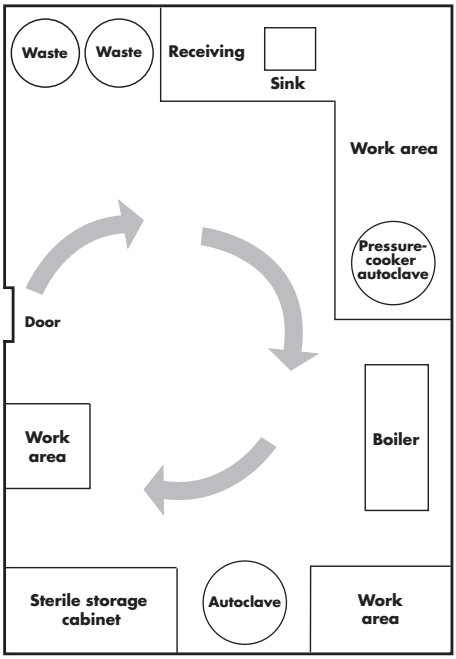
When processing items, activity patterns should be established so that soiled items never cross paths with clean, sterile, or HLD items.

It is ideal to have separate rooms—one for receiving and cleaning items and another for sterilization, HLD, and storage. However, in many settings, this is not possible. When only one room is available for processing, it should be arranged so that activities and objects flow in an organized fashion from receiving to storage. It is necessary to have at least one sink in processing areas (though having two sinks is preferred), sufficient countertop space for receiving dirty items and for drying and packaging clean items, and storage space (preferably closed cabinets).

Separate Rooms for Processing Instruments and Other Items



Single Room for Processing Instruments and Other Items



Tips for Organizing a Processing Area:

- Educate staff about the need to keep clean and sterile/HLD items from coming into contact with soiled items.
- Designate and label processing areas, particularly when only one room is available.
- Enclose processing rooms to minimize dust and eliminate insects.
- If possible, ensure access to two sinks or basins with a clean water supply (one sink for cleaning, one for rinsing).
- Store clean, sterile, and HLD instruments and other items on shelves with doors to minimize the amount of dust and debris falling onto the packaging.
- Avoid using cardboard boxes for storage, as they can harbor insects and shed dust and debris.
- Remove supplies from all shipping cartons and boxes before bringing them into an operating theater, procedure room, or clean work area.