Chemical Decontamination of Laboratory Wastes - SOP
Document Number: 526

The purpose of this SOP is to standardize the specific procedures to be used for the facility. This document should be customized to meet your facility's needs.

1. Purpose

The purpose of this SOP is to define the methods and procedures for decontaminating laboratory wastes using different chemicals of varying concentrations.

2. Scope

This SOP covers the selection of chemicals used for decontamination of laboratory wastes, such as hypochlorites, aldehydes and alcohols, appropriate concentrations for various treatments, procedures for various treatments, and proper disposal of decontaminated wastes and chemicals used in the decontaminating process.

In general, chemical disinfection should only be used when other reliable options are not available or when local law requires use of chemical methods.

3. Definitions

Refer to Doc 522: On-site Treatment and Disposal of Blood Transfusion Products – Guidance.

4. Responsibilities

4.1. It is the responsibility of all staff members intending to decontaminate laboratory waste to ensure that precautions and procedures are followed. The staff members include:

- Laboratory director
- Biosafety or chemical hygiene officer
- Laboratory supervisor
- Project director
- Laboratory staff

4.2. Laboratory directors must ensure that all staff involved in chemical decontamination are trained on:

- The hazards associated with use of the chemicals.
- The general safety precautions necessary for the handling, storage, and disposal of corrosives/oxidizers/flammables.
- Reactivity of the chemical disinfectants with other chemicals, water, heat or light.
- Autoclaving chemical waste (for staff that will use the autoclave for this purpose). Note: Chlorine compounds and alcohol should not be autoclaved. The training must include identification of chemicals that cannot safely be autoclaved.

5. Materials and Equipment

- Recommended chemical disinfectants
- Well-labeled waste containers, e.g., sharps containers, regular waste containers
- Personal protective equipment (PPE)
  - Lab coats
  - Masks
  - Gloves
  - Eye shields
- Spill kits
- Glass or plastic bottles of adequate volumes (e.g., 100 ml, 500ml, 10 litres, 50 litres)
- Measuring cylinders
- Plastic or metal funnel
- Distilled water

6. Hazards and Safety Concerns

6.1. Disinfectants are toxic and undue exposure may result in respiratory distress, skin rashes or conjunctivitis. Training on proper storage, mixing and application procedures is therefore essential. If used according to the manufacturers' instructions and national chemical safety regulations, they are safe and effective. (See Attachment 11.1: Potential Hazards of Some Chemical Disinfectants.)

6.2. Considering that chemical disinfectants are hazardous in nature, the method of disposal of the decontaminated material must be carefully chosen. Decontaminated liquid waste, for example, may be discharged into the public sewage system if the discharge is consistent with waste discharge requirements established by the local municipal council/regulation authority. Since disinfectants will also kill the microbes that are responsible for breaking down sewage in septic tanks, care should be taken to minimize the amount of disinfectant discharged to these systems. Large, intermittent discharges can be particularly harmful and should be avoided whenever possible. Persistent disinfectants should also be avoided whenever possible because of their potential impact on waste treatment systems.

6.3. Obtain MSDSs for all chemicals listing the stability, hazards and personal protection needed, as well as first aid information. This information should be available to all personnel. A 3-ring binder containing this information in one easily accessible location may be useful. MSDSs are supplied as product inserts but can also be obtained via the internet on authorized company/chemical specific websites.

6.4. When decontaminating wastes using chemicals, wear appropriate personal protective equipment such as gloves, lab coats, aprons, goggles and masks. (Refer to Doc 303: HCWM Worker PPE — Guidance.)

7. Procedures

7.1. General considerations for use of chemical disinfectants

7.1.1. The effectiveness of a chemical disinfectant is dependent on its working concentration. This must be defined for purposes of efficacy and compliance with the manufacturer's recommendations. Some products will have different dilutions depending on the desired use of the product (i.e., static versus cidal action).This concentration must be achieved when diluting the concentrated disinfectant in the waste liquid. Although some disinfectants may be more efficacious at higher concentrations, these levels may be limited by the degree of risk to personnel, surfaces or equipment, as well as the cost of the chemical.

7.1.2. The efficacy of chemical disinfectants also depends on contact time needed to kill versus inactivate microorganisms in the waste liquid. This is pathogen- and waste-dependent and must be verified for each situation. For example, 70% isopropyl alcohol can destroy mycobacterium tuberculosis in 5 minutes, whereas 3% phenol requires 2-3 hours. The minimum contact time needed is normally stated on the product label. Areas being disinfected should be well soaked with the disinfectant selected to avoid drying before the end of the optimum contact time. Some chemicals may have residual activity (i.e., QAC) while others may evaporate quickly (i.e., alcohols).

7.1.3. The method of applying the disinfectant matters. Object surfaces or walls of a building may be treated with a disinfectant solution by wiping, brushing, spraying or misting. Portable items should be soaked in a container of disinfectant. Fumigation may be used in some situations but is inefficient in buildings with ill-fitting doors and windows, or damaged roofs.

7.1.4. Stability and storage. Some disinfectants (i.e., sodium hypochlorite) degrade quickly after being diluted for use or when stored over long periods, especially in the presence of heat or light. Disinfectant product labels will list the shelf life of the concentrated product. To maximize stability and shelf life, store products in a dark, cool location and preferably in stock concentrations. It is usually recommended that disinfectants are prepared fresh on each day of use unless otherwise stated.

7.1.5. Organic load. Organic matter provides a physical barrier that protects microorganisms from contact with the disinfectant. Debris and organic material can also neutralize many disinfectants, especially chlorine and iodine containing compounds. Removal of all organic material prior to application of a disinfectant is essential as this can greatly impact the efficacy of the disinfectant.

7.2. Procedures for determining which waste requires chemical decontamination

7.2.1. Determine whether chemical disinfection is necessary. In some cases, autoclaving alone is enough unless the law requires additional pretreatment or items are regularly disposed of before later autoclaving, e.g., ongoing disposal of pipette tips during the day into liquid which is then drained and the tips autoclaved.

7.3. Procedures for selecting which disinfectants are suitable and for which types of waste.

The selection steps should be outlined in an action plan. The steps include:

- Assessment of which wastes need to be disinfected and any issues with that waste stream.
- Selection and preparation of disinfectant or assessment of available disinfectant (see below for method).

- Cleaning- this may be appropriate for reusable items.
- Disinfection and evaluation of efficacy of disinfection. This may not be necessary every time. See below for method.
- Budgetary allocation. Disinfectants usually vary in cost, contact time and dilution and as such, economic considerations are always important when selecting a disinfectant.

7.3.1. Assessment: The first step is a thorough assessment of the decontamination needs to include identifying and evaluating the infectious agents in question, the nature of the waste, as well as environmental factors (e.g., temperature, pH) and safety issues.

7.3.2. Selection of the proper chemical disinfectant. This should have proven efficacy with the waste in question or be evaluated according to the following procedure. Hypochlorite solutions have been proven to be effective disinfectants for most infectious waste streams. However, the selection of the disinfectant must be based upon the resistance of the microorganism. (Refer to Attachment 11.2 Descending Order of Resistance to Germicidal Chemicals and Attachment 11.3: Activity Levels of Selected Liquid Germicides.) Other considerations for disinfection selection should include factors such as shelf life stability, disposal restrictions, safety, and chemical agent advantages/disadvantages (Refer to Attachment 11.4: Comparison of the Characteristics of Selected Chemicals Used as High-level Disinfectants or Chemical Sterilants and Attachment 11.5: Summary of Advantages and Disadvantages of Chemical Agents Used as Chemical Sterilants or as High-level Disinfectants).

To test disinfectant to determine the required effective dilution, the time taken to effect disinfection, and to periodically monitor activity of disinfectant:

- Prepare 24-hour growth blood agar cultures of *Staph. aureus, E.coli*, and Pseudomonas and using these cultures, prepare individual solutions in PBS (phosphate buffered saline) to give a concentration of a MacFarlands Standard Tube 5.
- Prepare the chosen dilution of the disinfectant to be used.
- Transfer 2 ml of each organism solution to 8 ml of freshly prepared disinfectant and leave for 24 hours on the bench.
- After 24 hours remove 1 ml of the disinfectant solution and streak onto a blood agar plate and incubate at 37°C for 24 hours.
- Examine after 24 hours. No growth (sterility) indicates that the disinfection process was adequate. If growth does occur, repeat the process using a more concentrated solution of the disinfectant until sterility is observed.

The overall effectiveness of the chemical disinfectant is also dependent on the presence and amount of organic materials and pathogens/organisms present. If you plan to use chemical disinfectants to sterilize waste that contains organic materials for example, then it is preferable to add some of the organic materials to this verification test as well. For example, addition of biological fluids such as blood samples to mimic the presence of organic material.

7.3.3. Prepare the chemical disinfectant with required concentration

Some working solutions are described in terms of the concentration of active agent in the working solution. If the stock solution is not 100% active ingredient, then you must calculate the concentration of active ingredient in the stock to get the correct concentration in the final working solution. Use the following equation, or the quick methods below for commonly used solutions.

$$\text{Total Parts (TP)} (H_2O) = \left[\frac{\%\ \text{Concentrate}}{\%\ \text{Dilute}} \right] - 1$$

- To make 0.5 % hypochlorite disinfectant from household bleach (5% w/v), dilute 1 part concentrated solution and add to 9 parts water (filtered if necessary). Note that 5% hypochlorite is not available in all countries and it may be necessary to adapt according to what is available locally. Bleach can be used as a general purpose disinfectant and for soaking contaminated metal-free materials (it is highly alkaline and can be corrosive to metal).
- To make 70% ethanol or isopropanol, dilute 700 ml of alcohol with 300 ml of water. 70% ethyl alcohol is used for routine clean-up of working surfaces in the laboratory.
- To make 8% formaldehyde, dilute 1 part formaldehyde (35-40%) solution to 4 parts boiled water. It is effective against vegetative bacteria, spores, and viruses.
- To make 6% hydrogen peroxide, dilute 1 part hydrogen peroxide (30%) solution to 4 parts boiled water
- To make 5% phenol, melt 50 grams of phenol crystals in a boiling water bath and add to 1 litre of water slowly in a plastic tub. 5% phenol is used for cleaning up sputum spills in soaked paper towels to cover working surfaces.

Note: **Disinfectant solutions should be freshly prepared and changed daily. Do not add fresh disinfectant to an old solution.**

7.3.4. Cleaning/washing: This step helps to remove organic debris or waste that may inactivate the decontaminant.

For wastes involving surfaces, cleaning may appear to remove all debris, but a biofilm may remain and interfere with disinfection efficacy. Biofilm is a complex aggregation of bacteria adhering to surfaces in an exopolysaccharide matrix, resulting in a thin residue remaining after cleaning.

7.3.5. Disinfection: Always read the entire product label and follow the instructions for use explicitly to ensure that the safest, most effective concentration is applied. Disinfectant should remain for the appropriate contact time, which will vary with the product.

7.3.6. Evaluation: To verify that the targeted microorganisms have been destroyed, a follow-up evaluation should be conducted on a regular basis.

To estimate the number of living organisms in a vessel of disinfectant in actual use, perform practical test, Maurer’s ‘In-use test’ as follows:

- The disinfectant that is already in use is diluted 1 in 10 by mixing 1 ml of the disinfectant with 9 ml of sterile nutrient broth.
- Ten drops of the diluted disinfectant (0.02 ml) is placed on two nutrient agar plates.
- One plate is incubated at 37°C for 3 days while the other is held at room temperature for 7 days.

- The number of drops that yielded growth is counted after incubation.
- If there is growth in more than five drops on either plate, it represents failure of disinfectant.
- Store diluted solutions in sealed plastic containers that are protected from light.

7.3.7. Before storing in plastic containers, make sure that the disinfectant to be prepared does not corrode plastic. If it does, then use glass containers. Hydrogen peroxide, iodine, chlorine compounds and phenols are corrosive.

7.4. Procedures for disposal of the disinfectants and the decontaminated waste.

7.4.1. Once you have followed the decontamination procedures, appropriately dispose of decontaminated laboratory waste and any waste chemical disinfectants. Categorize the waste into types using the laboratory regulations.

In an ideal situation, the disinfected waste will not adversely affect the waste liquid waste treatment system or the environment into which it is to be discharged. In this case, it should be disposed of to a drain with suitable precautions against splashing and aerosols. The disposal location should be designated for the purpose and be inaccessible to the public. The sink or other disposal location should be cleaned after each disposal. See the related document on sanitary sewer disposal of liquid laboratory waste for further information (Doc 521: Sanitary Sewer Disposal of Liquid Laboratory Waste – Guidance).

7.4.2. If the waste cannot be disposed of to a drain, the laboratory should arrange to dispose of all wastes regularly.

7.4.3. Prepare for disposal by storing it in a well-labeled leak-proof container if it is a liquid chemical. If sharps are contaminated with chemicals, store them in a watertight sharps container.

7.4.4. The persons generating the waste should package, label and deliver them to the pick-up point.

7.4.5. If wastes are not collected and disposed of appropriately, document corrective and preventive actions.

7.4.6. In case of any spillage or incident, notify the head of the laboratory and refer to Doc 304: Biological Spill Clean-up — SOP.

7.4.7. Refer to Attachment 11.1 for a table of common solutions and which degrade, are chlorinated, react to produce chlorinated byproducts.

7.5. Procedures for chemical decontamination of pipette tips and vacutainers

7.5.1. Commercial sodium hypochlorite solutions contain significant amounts of chloroform and bromodichloromethane. Disposable plastic, glass, and paper (e.g., pipette tips, vacutainers, gloves, etc.) that contact blood should be decontaminated with a freshly prepared bleach solution (a 10% dilution of commercial sodium hypochlorite (bleach) or equivalent) before re-use or disposal.

8. Reporting and Recordkeeping

8.1. Records of the chemical decontamination protocol to which each load of waste was subjected should be kept by the facility as evidence that the load has been treated.

9. References

9.1. Rutula WA, Weber DJ. Healthcare Infection Control Practices Advisory Committee. Guideline for disinfection and sterilization in healthcare facilities. Atlanta (GA): Centers for Disease Control and Prevention; 2008. http://www.cdc.gov/ncidod/dhqp/pdf/guidelines/Disinfection_Nov_2008.pdf

9.2. Weber DJ, Barbee SL, Sobse MD, Rutal WA. The effect of blood on the anitiviral activity of sodium hypochlorite, a phenolic, and a quaternary ammonium compound. Infection Control and Hospital Epidemiology 1999; 20(12): 821-827.

9.3. Dvorak G. (2005). Disinfection 101. Aimes (IA): Center for Food Security and Public Health; 2008. http://www.cfsph.iastate.edu/BRM/resources/Disinfectants/Disinfection101.pdf

9.4. Chosewood LC, Wilson DE. Biosafety in microbiological and biomedical laboratories. US Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institutes of Health; 2009. http://www.cdc.gov/od/ohs/biosfty/bmbl5/bmbl5toc.htm

10. Related Documents

- Doc 303: HCWM Worker PPE — Guidance
- Doc 304: Biological Spill Clean-up — SOP
- Doc 308: Incident Reporting Form

11. Attachments

11.1. Potential Hazards of Some Chemical Disinfectants

11.2. Descending Order of Resistance to Germicidal Chemicals

11.3. Activity Levels of Selected Liquid Germicides

11.4. Comparison of the Characteristics of Selected Chemicals Used as High-level Disinfectants or Chemical Sterilants

11.5. Summary of Advantages and Disadvantages of Chemical Agents Used as Chemical Sterilants or as High-level Disinfectants

Attachment 11.1: Potential Hazards of Some Chemical Disinfectants

Category	Chemical Disinfectants	Application	Potential Hazards
Alcohols	• Ethyl alcohol • Isopropyl alcohol	• A 70% aqueous solution is more effective at killing microbes than absolute alcohols	• The chemicals are flammable and could form explosive vapor • They may react violently with strong oxidants. • Irritate skin and cause dermatitis. • Inhalation of concentrated alcohol vapor may cause irritation of the respiratory tract and effects on the central nervous system
Aldehydes	• Formaldehyde • Paraformaldehyde • Glutaraldehyde • Ortho-phthalaldehyde (OPA)	• 2% glutaraldehyde is used to sterilize thermometers, centrifuges, etc.	• These chemicals are irritating, toxic to humans upon contact or inhalation of high concentrations. Formaldehyde in gas form is extremely flammable. It forms explosive mixtures with air. • It should only be used in well-ventilated areas. • Formaldehyde is a known human carcinogen.
Chlorine Compounds (Hypochlorites)	• Sodium hypochlorite • Calcium hypochlorite • Sodium dichloroisocyanurate	• Used at a dilution of 1:10 in decontamination of spillage of infectious material • 0.5% sodium hypochlorite is used in serology and virology • Rapidly inactivated in the presence of organic matter	• Mixing hypochlorites with strong acids may result in violent chemical reaction that could release toxic gases. • These chemicals may cause skin irritation. Concentrated hypochlorites solutions can cause chemical burns of the skin.
Oxidizing Agents	• Hydrogen peroxide • Peroxyacetic acid	• It is used at 6% concentration to decontaminate the instruments, equipment such as ventilators.	• Concentrated peroxide solutions are reactive and explosive. • The chemicals are irritants and may cause chemical burns of the skin and eyes when concentrated.

Category	Chemical Disinfectants	Application	Potential Hazards
Phenols	• Cresol • Hexachlorophene	• It is used at 5% concentration to decontaminate the TB laboratory spills	• Phenols can cause skin and eye irritation • When phenol compounds are inhaled, ingested, or applied to the skin at high concentrations, the chemicals are harmful to human.
Others	• Ethylene Oxide	• It is used to sterilize heat labile articles such as plastics, syringes, and disposable petri dishes • Decomposes in light, broken down by catalase, proteinous organic matter drastically reduces its activity.	• Ethylene oxide is highly flammable and explosive. • Highly mutagenic and carcinogenic.

Attachment 11.2 Descending Order of Resistance to Germicidal Chemicals

Source: Chosewood, L. C., & Wilson, D. E. (2009), see Reference 9.4

Bacterial Spores

Bacillus subtilis, Clostridium sporogenes

▼

Mycobacteria

Mycobacterium tuberculosis var. *bovis*, Nontuberculous mycobacteria

▼

Nonlipid or Small Viruses

Poliovirus, Coxsackievirus, Rhinovirus

▼

Fungi

Trichophyton spp., *Cryptococcus* spp., *Candida* spp.

▼

Vegetative Bacteria

Pseudomonas aeruginosa, Staphylococcus aureus, *Salmonella choleraesuis*,

Enterococci

▼

Lipid or Medium-size Viruses

Herpes simplex virus, CMV, Respiratory syncytial virus, HBV, HCV, HIV, Hantavirus, Ebola virus

Attachment 11.3: Activity Levels of Selected Liquid Germicides[a]

Source: Chosewood, L. C., & Wilson, D. E. (2009), see Reference 9.4

Procedure / Product	Aqueous Concentration	Activity Level
Sterilization		
glutaraldehyde	variable	
hydrogen peroxide	6 – 30%	
Formaldehyde	6 – 8%	
chlorine dioxide	variable	
peracetic acid		
Disinfection		
glutaraldehyde	variable	high to intermediate
ortho-phthalaldehyde	0.50%	high
hydrogen peroxide	3 – 6%	high to intermediate
formaldehyde [b]	1 – 8%	high to low
chlorine dioxide	variable	high
peracetic acid	variable	high
chlorine compounds [c]	500 to 5000 ml/L free/available chlorine	Intermediate
alcohols (ethyl, isopropyl) [d]	70%	Intermediate
phenolic compounds	0.5 to 3%	intermediate to low
iodophor compounds [e]	30 – 50 mg/L free iodine up to 10,000 mg/L available iodine 0.1 – 0.2%	intermediate to low
quaternary ammonium compounds		low

a. This list of chemical germicides centers on generic formulations. A large number of commercial products based on these generic components can be considered for use. Users should ensure that commercial formulations are registered with EPA or by the FDA.

b. Because of the ongoing controversy of the role of formaldehyde as a potential occupational carcinogen, the use of formaldehyde is limited to certain specific circumstances under carefully controlled conditions (e.g., for the disinfection of certain hemodialysis equipment). There are no FDA cleared liquid chemical sterilant/disinfectants that contain formaldehyde.

c. Generic disinfectants containing chlorine are available in liquid or solid form (e.g., sodium or calcium hypochlorite). Although the indicated concentrations are rapid acting and broad-spectrum (tuberculocidal, bactericidal, fungicidal, and virucidal), no proprietary hypochlorite formulations are formally registered with EPA or cleared by FDA. Common household bleach is an excellent and inexpensive source of sodium hypochlorite. Concentrations between 500 and 1000 mg/L chlorine are appropriate for the vast majority of uses requiring an intermediate level of germicidal activity; higher concentrations are extremely corrosive as well as irritating to personnel, and their use should be limited to situations where there is an excessive amount of organic material or unusually high concentrations of microorganisms (e.g., spills of cultured material in the laboratory).

d. The effectiveness of alcohols as intermediate level germicides is limited because they evaporate rapidly, resulting in short contact times, and also lack the ability to penetrate residual organic material. They are rapidly tuberculocidal, bactericidal and fungicidal, but may vary in spectrum of virucidal activity (see text). Items to be disinfected with alcohols should be carefully pre-cleaned then totally submerged for an appropriate exposure time (e.g., 10 minutes).

e. Only those iodophors registered with EPA as hard-surface disinfectants should be used, closely following the manufacturer's instructions regarding proper dilution and product stability. Antiseptic iodophors are not suitable to disinfect devices, environmental surfaces, or medical instruments.

Attachment 11.4: Comparison of the Characteristics of Selected Chemicals Used as High-level Disinfectants or Chemical Sterilants

Source: Rutala and Weber (2008), see Reference 9.1

	Hydrogen peroxide (7.5%)	Peracetic acid (0.2%)	Glutaraldehyde (≥2.0%)	Ortho-phthalaldehyde (0.55%)	HP/PA (7.35%/0.23%)
HLD claim	30 m @ 20°C	NA	20-90 m @ 20°-25°C	12 m @ 20°C, 5 m @ 25°C in AER	15 m @ 20°C
Sterilization claim	6 h @ 20°	12m @ 50-56°C	10 h @ 20°-25°C	None	3 h @ 20°C
Activation	No	No	Yes (alkaline glut)	No	No
Reuse life[1]	21d	Single use	14-30 d	14d	14d
Shelf life stability[2]	2 y	6 mo	2 y	2 y	2 y
Disposal restrictions	None	None	Local[3]	Local3	None
Materials compatibility	Good	Good	Excellent	Excellent	No data
Monitor MEC[4]	Yes (6%)	No	Yes (1.5% or higher)	Yes (0.3% OPA)	No
Safety	Serious eye damage (safety glasses)	Serious eye and skin damage (conc soln) [5]	Respiratory	Eye irritant, stains skin	Eye damage
Processing	Manual or automated	Automated	Manual or automated	Manual or automated	Manual
Organic material resistance	Yes	Yes	Yes	Yes	Yes
OSHA exposure limit	1 ppm TWA	None	None[6]	None	HP-1 ppm TWA
Cost profile (per cycle)[7]	+ (manual), ++ (automated)	+++++(automated)	+ (manual), ++ (automated)	++ (manual)	++ (manual)

NOTES ON ATTACHMENT 11.4

Abbreviations: HLD=high-level disinfectant; HP=hydrogen peroxide; PA=peracetic acid;glut=glutaraldehyde; PA/HP=peracetic acid and hydrogen peroxide; OPA =ortho-phthalaldehyde (FDA cleared as a high-level disinfectant, included for comparison to other chemical agents used for high-level disinfection); m=minutes; h=hours; NA=not applicable; TWA=time-weighted average for a conventional 8-hour workday.

1. number of days a product can be reused as determined by re-use protocol
2. time a product can remain in storage (unused)
3. no U.S. EPA regulations but some states and local authorities have additional restrictions
4. MEC=minimum effective concentration is the lowest concentration of active ingredients at which the product is still effective
5. Conc soln=concentrated solution
6. The ceiling limit recommended by the American Conference of Governmental Industrial Hygienists is 0.05 ppm
7. per cycle cost profile considers cost of the processing solution (suggested list price to healthcare facilities in August 2001) and assumes maximum use life (e.g., 21 days for hydrogen peroxide, 14 days for glutaraldehyde), 5 reprocessing cycles per day, 1-gallon basin for manual processing, and 4-gallon tank for automated processing. + = least expensive; +++++ = most expensive

Attachment 11.5: Summary of Advantages and Disadvantages of Chemical Agents Used as Chemical Sterilants[1] or as High-level Disinfectants

Source: Rutala and Weber (2008), see Reference 9.1

Sterilization method	Advantages	Disadvantages
Peracetic Acid/Hydrogen Peroxide	No activation required	Materials compatibility concerns (lead, brass, copper, zinc) both cosmetic and functional
	Odor or irritation not significant	Limited clinical experience
		Potential for eye and skin damage
Glutaraldehyde	Numerous use studies published	Respiratory irritation from glutaraldehyde vapor
	Relatively inexpensive	Pungent and irritating odor
	Excellent materials compatibility	Relatively slow mycobactericidal activity
		Coagulates blood and fixes tissue to surfaces
		Allergic contact dermatitis
		Glutaraldehyde vapor monitoring recommended
Hydrogen Peroxide	No activation required	Material compatibility concerns (brass, zinc, copper, and nickel/silver plating) both cosmetic and functional
	May enhance removal of organic matter and organisms	Serious eye damage with contact
	No disposal issues	
	No odor or irritation issues	
	Does not coagulate blood or fix tissues to surfaces	
	Inactivates *Cryptosporidium*	
	Use studies published	
Ortho-phthalaldehyde	Fast acting high-level disinfectant	Stains skin, mucous mebranes, clothing, and environmental surfaces
	No activation required	Repeated exposure may result in hypersensitivity in some patients with bladder cancer
	Odor not significant	More expensive than glutaraldehyde
	Excellent materials compatibility claimed	Eye irritation with contact
	Does not coagulate blood or fix tissues to surfaces claimed	Slow sporicidal activity
Peracetic Acid	Rapid sterilization cycle time (30-45 min)	Potential material incompatibility (e.g., aluminum anodized coating becomes dull)

Sterilization method	Advantages	Disadvantages
	Low temperature (50-55°C) liquid immersion sterilization	Used for immersible instruments only
	Environmental friendly by-products (acetic acid, O_2, H_2O)	Biological indicator may not be suitable for routine monitoring
	Fully automated	One scope or a small number of instruments can be processed in a cycle
	Single-use system eliminates need for concentration testing	More expensive (endoscope repairs, operating costs, purchase costs) than high-level disinfection
	Standardized cycle	Serious eye and skin damage (concentrated solution) with contact
	May enhance removal of organic material and endotoxin	Point-of-use system, no sterile storage
	No adverse health effects to operators under normal operating conditions	
	Comatible with many materials and instruments	
	Does not coagulate blood or fix tissues to surfaces claimed	
	Sterilant flows through scope facilitating salt, protein, and microbe removal	
	Rapidly sporicidal	
	Provides procedure standardization (constant dilution, perfusion of channels, temperatures, exposure)	

[1]All products effective in presence of organic soil, relatively easy to use, and have a broad spectrum of antimicrobial activity (bacteria, fungi, viruses, bacterial spores, and mycobacteria). The above characteristics are documented in the literature; contact the manufacturer of the instrument and sterilant for additional information. All products listed above are FDA-cleared as chemical sterilants except OPA, which is an FDA-cleared high-level disinfectant.