Infection Prevention and Control Best Practices

For Small Animal Veterinary Clinics

Dear veterinary staff member,

We are conducting a brief online survey to understand your current infection control practices and your motivation for seeking out these guidelines. Participation in the survey is strictly voluntary. You may exit the survey at any time, and you may skip any questions you wish. All responses are anonymous

This survey should only take approximately 2-3 minutes to complete. We would greatly appreciate your feedback.

Click this link to start the survey:

https://uoguelph.eu.qualtrics.com/jfe/form/SV_6DbIPOk3dZnLbQ9

Cleaning, Disinfection, Sterilization

Cleaning and disinfection are two separate tasks. **Cleaning** involves the removal of visible organic matter and scrubbing with soap or detergent, whereas **disinfection** involves the application of a chemical or other procedure in order to kill the majority of microbes that cannot be adequately removed by cleaning. **Sterilization** is the elimination of all viable microbes, including those that are not killed by disinfection. Cleaning is essential because the survival time of many infectious agents outside the host is prolonged by the presence of organic matter, and organic matter also decreases the effectiveness of disinfection and sterilization. Depending on the level of disinfection used, disinfection kills or prevents the growth of many or most pathogens.

Equipment should be cleaned and disinfected according to its intended use, the manufacturer's recommendations, and practice policy. Equipment must be cleaned before disinfection or sterilization. Surfaces where animals are housed, examined, or treated should be made of non-porous, sealed, easy-to-clean materials to facilitate cleaning and disinfection and minimize pathogen transmission.

Personnel whose duties include cleaning and disinfection or sterilization of equipment and different hospital areas should be trained on how to safely handle and use the products available in the clinic for these procedures. In Canada, Material Safety Data Sheets (MSDS) must be readily accessible for all applicable chemical products.

Cleaning

Cleaning entails the removal of all visible organic matter of any kind (e.g. feces, urine, blood, food, dirt etc.) from a surface using soap, detergent, or other such product, or other physical means (e.g. ultrasonic cleaner). It is especially important in the presence of pathogens that are resistant to most disinfectants (e.g. *Cryptosporidium* spp.). The mechanical action of cleaning physically removes these organisms from a surface. It is necessary for both environmental and equipment surfaces (see Sterilization section for additional information on cleaning instruments and equipment prior to sterilization). Cleaning must always be done before a disinfectant is used or before sterilization is performed.

Cleaning procedures

When using a cleaning product:

- Ensure the area is well ventilated.
- Bear in mind that during cleaning, it is the mechanical action of scrubbing and the surfactant properties of the product that are important, not the product's antimicrobial activity.
- Wear gloves during the procedure, and wash hands once complete. Other personal protective equipment, such as eye protection or respiratory protection, may be required depending on the situation.
- Ensure any residue from chemical cleaning products is rinsed off or otherwise removed when done.
- Allow all surfaces to dry completely once complete.

Recommended cleaning procedures for common environmental surfaces are shown in Table 1.

Removing loose, dry debris from surfaces:

- Avoid generating airborne dust that may contain pathogens by:
  - using a vacuum cleaner equipped with a HEPA filter
- The filter helps to prevent aerosolization of pathogens such as ringworm. For this reason, vacuums without HEPA filters should not be used for cleaning in patient areas.
  - lightly spraying surfaces with water prior to wiping or sweeping
  - using an electrostatic wipe (e.g. Swiffer™ cloth)
  - using a wet mop

- Exposure to aerosols generated by brushes during cleaning can be minimized by taking certain precautions, such as wearing a face mask and containing spatter if the brush or surface is damp. A surgical nose-and-mouth mask will provide some protection against droplet spatter. For finer particles and dry dust that can become suspended in the air, a properly-fitted N95 respirator is needed for protection (see respiratory protection section in Chapter: Personal Protective Equipment).

Removing sticky, wet or dried-on organic material from surfaces:

- Use a detergent or soap and a brush or cloth, as necessary.
- Avoid the use of pressure washers, particularly those that produce more than 120 psi. This amount of pressure may cause aerosolization of pathogens, and may even damage surfaces, thus making them harder to clean and disinfect over time. A home garden hose sprayer usually produces less than 120 psi of pressure, and would therefore be relatively safe to use in a small animal kennel area.

Disinfection

Disinfection can only be maximally effective if it is preceded by thorough cleaning. Some pathogens (e.g. clostridial spores) are highly resistant to disinfection, therefore cleaning in these cases is particularly crucial in order to mechanically remove the organisms.

Disinfection procedures

When using a disinfectant (adapted from PHO 2018):

- Ensure all areas are well ventilated.
- Wear gloves when handling disinfectants. Note that latex gloves will lose their integrity when exposed to many chemicals. For small jobs, use disposable nitrile gloves instead. For large jobs, heavier rubber gloves (e.g. common dishwashing gloves) can be used, but reusable gloves of this type must themselves also be disinfected at the end of each task.
- Wear eye protection in case of splashes.
- Always apply the selected disinfectant according to the product label, with particular attention to:
  - appropriate dilution
  - required contact time
- If patients or personnel may have direct skin contact with the surface, if the surface is used for food preparation, or if the disinfectant used may damage a particular surface, the disinfectant may need to be rinsed off with clean water after an appropriate amount of time has elapsed.
- After disinfection, allow all surfaces to dry completely.

It is also important to reduce the risk of contamination of the disinfection equipment and containers. Proper dilution of products, frequent refreshing of solutions, use of clean cloths and wipes, and periodic cleaning and disinfection of the equipment and containers themselves (including complete emptying and allowing to dry) will help achieve this goal. Depending on the product, test strips are available that can be used to verify ongoing activity of the diluted (i.e. in-use) disinfectant if stored or maintained in basins for a long duration. Also see References for an online bleach dilution calculator (PHO).

Environmental cleaning and disinfection

Environmental surfaces that are not in direct contact with patients are generally low risk in terms of contributing to pathogen transmission. Routine cleaning with or without disinfection are adequate for these surfaces (e.g. walls, chairs, monitors, cabinets) in most cases. See Table 3 for recommendations regarding cleaning and disinfecting such surfaces. Compared to human healthcare facilities, particular attention needs to be paid to the cleaning and disinfection of floors, as patients and personnel often have very close contact with the floor.

Cleaning must always be done before a disinfectant is used or before sterilization is performed.

TABLE 3. Recommended cleaning and disinfection procedures for common environmental surfaces (also see disinfectant selection section).

Surface/Object	Procedures	Special Considerations
Horizontal surfaces with low patient contact (e.g. front desk, records area)	• Clean regularly with detergent, e.g. bi-weekly • Clean and disinfect promptly if visibly soiled with feces, urine or body fluids	Electrostatic wipes (e.g. Swiffer™ cloths) can be used to remove loose fur and dust
Horizontal surfaces with high patient contact (e.g. exam tables, scale, kennels)	• Clean and disinfect between all patients • Provide enhanced disinfection after contact with high-risk patients (e.g. diarrheic). A broader-spectrum disinfectant (e.g. bleach, oxidizing agent) should be used if narrower-spectrum disinfectants are used routinely (see disinfectant selection section)	
Vertical surfaces (e.g. walls, doors, windows including blinds/ curtains)	• Clean regularly with a detergent, e.g. monthly • Clean and disinfect promptly if visibly soiled with feces, urine or body fluids	
Hard floors (e.g. tile, wood, sealed cement)	• Clean daily with a detergent and disinfect regularly, e.g. weekly • Clean and disinfect after potentially infectious patients • Clean and disinfect promptly if visibly soiled with feces, urine or body fluids	
Carpets/upholstery	• Vacuum regularly, e.g. monthly • Use a vacuum equipped with a HEPA filter, especially if there may have been contact with an animal shedding an infectious pathogen (e.g. ringworm) • Shampoo or steam clean if necessary to remove persistent dirt and stains	Cleaning is especially important for these surfaces as they are difficult or impossible to disinfect
Food and water bowls	• Cleaning alone (with regular dish soap) is adequate for food and water bowls from non-infectious patients • Clean and disinfect after potentially infectious patients, and do not clean with bowls from other patients, or use disposable bowls	Use a disinfectant approved for use on food surfaces
Toys and miscellaneous items	• Clean and disinfect between patients, or discard if not amenable to proper cleaning and disinfection (e.g. cloth toys)	Wear gloves when handling items from patients with known or suspected zoonotic pathogens or any items that are visibly soiled
Litter boxes	• Clean out at least daily • Completely empty and disinfect between patients	Ideally, litter boxes should not be handled by pregnant women, however daily cleaning & disinfection reduces the risk of contact with the infectious stage of certain parasites

Footbaths and footmats

Data regarding the need for and efficacy of footbaths and footmats are very limited, and there is essentially no information related to small animal clinics specifically. It has been shown that footbaths can reduce bacterial contamination of footwear in large animal clinic settings (Hornig 2016). Although other sources of contamination have been shown to be more significant in infection transmission, footwear and floor surfaces cannot be overlooked in an infection control program in a small animal clinic, because patients so often have extensive direct contact with the floor. In addition, footbaths or footmats can be a useful visual indicator of an area of increased infectious disease risk.

Footbaths are shallow containers filled with a disinfectant solution. Footmats are spongy mats covered with a durable, easy-to-clean material that can be saturated with disinfectant. Footmats can increase compliance because they are easier to use, but they are more expensive and more difficult to maintain than footbaths. Footbath or footmat use is almost invariably accompanied by spillage of disinfectant solution; this can create a slipping hazard on smooth floor surfaces, which are typically present in small animal clinics. Slipping risks can be reduced with the use of a "walk of"' mat to provide traction. Some disinfectants can also damage floor surfaces with prolonged contact.

Footbaths or footmats should be considered when personnel will be walking on a surface that could potentially be more contaminated than the rest of the floor in general, and where spread of this contamination might pose a risk to patients or personnel. The most likely area where footbaths or footmats could be useful is at the exit of an animal housing area (e.g. dog run) that contains a potentially infectious case, and where clinic personnel will be walking in and out of the potentially contaminated area. The need for routine use of footbaths or footmats in isolation areas where animals are confined in cages is questionable. If used, select a disinfectant that is effective against the specific pathogen(s) of concern, stable in solution, and effective with a relatively short contact time (see Tables 4 and 5). Oxidizing agents such as accelerated/stabilized hydrogen peroxide and peroxygen disinfectants are ideal. The solution should be changed daily, or sooner if gross contamination of the bath/mat occurs. Maintaining proper concentration of active disinfectants in footbaths and footmats is essential for proper performance.

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Equipment disinfection

Single-use equipment (e.g. hypodermic needles) should not be re-sterilized or disinfected for re-use. Such items should be properly disposed of immediately after initial use. In veterinary medicine, although it is not considered best-practice, some equipment that is classified as single-use in human healthcare is reused because the cost of some items makes it impractical to discard them after a single use (see disinfection of anesthetic equipment section in Chapter: Surgery). There is little to no objective information on how to disinfect or sterilize such equipment, and how often this can be done without compromising the integrity of the item. The level of disinfection required should be evaluated as for multi-use equipment (below). Items should be carefully inspected prior to each use and replaced if there is evidence of damage that may impair the function of the equipment or subsequent cleaning and disinfection. In some areas, licensed third party companies may exist that can provide reprocessing services for some equipment.

Multi-use equipment must be properly cleaned and disinfected between each patient. There are three categories of multi-use equipment used on patients: **critical, semi-critical** and **non-critical.** Each category defines how instruments must be cleaned and disinfected to prevent transmission of infectious agents. In human healthcare, these categories are defined as per Table 4.

TABLE 4. Spaulding's classification of medical equipment / devices and required levels of processing and reprocessing (Spaulding 1970).

Classification	Definition	Level of processing / reprocessing
Critical equipment/device (e.g. surgical instruments)	Equipment/device that enters sterile tissues, including the vascular system	Cleaning followed by sterilization
Semi-critical equipment/ device (e.g. endoscopes, thermometers)	Equipment/device that comes in contact with non-intact skin or mucous membranes but does not penetrate them	Cleaning followed by high level disinfection (as a minimum), sterilization is preferred
Non-critical equipment/device (e.g. stethoscope)	Equipment/device that touches only intact skin and not mucous membranes, or does not directly touch the patient	Cleaning followed by low level disinfection, in some cases, cleaning alone is acceptable

See Tables 5 (below), 6 and 7 for selection of disinfectants.

The CDC defines **high level disinfection** as use of a chemical agent capable of killing all vegetative microorganisms, but not all bacterial spores. These agents can be used as chemical sterilants, but should not be used for general environmental cleaning. **Low level disinfection**, on the other hand, is use of an agent capable of killing vegetative bacteria, some viruses and fungi, but no bacterial spores. These products may lack a tuberculocidal claim as well. They are ideal for environmental cleaning and disinfection. Table 5 below lists common disinfectants used for the different levels of disinfection. Additional information is available from various online resources (PHO 2018, Rutala 2008).

In veterinary medicine, exceptions to the level of processing required are typically made for some pieces of semi-critical equipment that come in contact with tissues or mucous membranes which are normally considered non-sterile, such as those of the upper respiratory or gastrointestinal tracts. If a transmissible infectious disease is not suspected in the patient, and the subsequent patient is not significantly immunocompromised, thorough cleaning and low level disinfection is likely adequate in these cases. However, if an infectious disease is suspected or the subsequent patient is immunocompromised, then cleaning and high level disinfection or sterilization are recommended in order to prevent disease transmission. For example, a rectal thermometer should undergo cleaning and low level disinfection between every patient, but if used on a diarrheic animal it should undergo high level disinfection, be discarded and replaced, or disposable protective covers should be used followed by disinfection.

TABLE 5. Common chemical disinfectants (Modified from PHO 2018, Rutala & Weber 2016)

	Low Level Disinfection	High Level Disinfection	Sterilization
Equipment	Non critical equipment	Semi-critical equipment	Critical equipment
Chemical	60-95% Alcohol 0.5% AHP (1-5min) 1:100 bleach (10min) QACs 3% HP	1% HP + 0.08% PA (25min) 7.35% HP + 0.23% PA (15min) >2% glut (20-90min) 2% HP (8min) 0.55% OPA (12min) 2% AHP (5-8mins) 1:50 bleach (10min)	Vapourized HP Ozone HP/ozone >2% glut (10 hours) 0.2% PA (12mins at 50-56C) 6-25% HP (6hours) 2% AHP (6 hours) 7% AHP (20mins) 1:10 bleach (10min)

Contact times and concentrations are guidelines only. Always follow the manufacturer's instructions for the specific product being used.
glut – glutaraldehyde, **HP** – hydrogen peroxide, **PA** – peracetic acid, **OPA** - Ortho-phthalaldehyde, **AHP** – accelerated hydrogen peroxide, **QAC** – quaternary ammonium compound

The following section outlines basic cleaning and disinfection recommendations for select equipment. Detailed instructions for these and other devices should be available from the manufacturer.

Endoscopes: Proper cleaning and maintenance of endoscopes are important to prolonging the useful life of the instrument, but cleaning and disinfection are also important in terms of infectious disease control. Endoscopes are semi-critical equipment, and as such require high-level disinfection when used in humans. In veterinary medicine, high-level disinfection is required prior to use in relatively sterile areas (e.g. urinary tract), and should be considered best-practice for use in in non-sterile areas as well (e.g. gastrointestinal tract, upper respiratory tract), even though thorough low-level disinfection is often used for the latter. Manufacturers typically provide detailed reprocessing (cleaning and disinfection) instructions for their instruments, which should be readily available as a reference for staff members responsible for the care of endoscopes. If the endoscope was purchased second hand and the reprocessing instructions were not provided, it is important to contact the manufacturer to obtain a copy. Some general guidelines regarding endoscope maintenance are as follows (adapted from Rutala 2008):

1. **Clean: Endoscopes (and associated equipment) must be meticulously cleaned immediately after every use.** This involves first removing visible organic matter to prevent debris from drying onto surfaces, as this can make the debris considerably harder to remove. Endoscopes typically have several moving or detachable parts and small channels in which moisture, debris and discharge can become trapped. After cleaning the visible debris from the scope, it should be disassembled and cleaned with water and a detergent or enzymatic cleaner. Leak testing should be done prior to immersion. The scope should be dried before proceeding to disinfection.
   - **All instrument and suction channels must be thoroughly cleaned after each use**, even if the channels were not used during the procedure. Failure to clean these channels is a common error which can result in accumulation of debris, bacteria and biofilms within the instrument. Not only does this pose a risk of disease transmission to subsequent patients, but it can also confound sample collection and culture.
2. **Disinfect:** All channels of the endoscope must be disinfected using a **low level disinfectant, at a minimum**. High level disinfection is required prior to procedures involving sterile areas, and should be considered best-practice prior to any use. Immersion of the endoscope in the solution and perfusion through the channels to remove air pockets ensures all surfaces come into contact with the disinfectant. Consult the manufacturer's instructions regarding what methods can be safely used for any particular endoscope. If a chemical sterilant is used, **a timer should be used to measure the exact contact time** — too short a time may result in an inadequate microbial killing, while too long a time may result in damage to the instrument.
3. **Rinse:** Failure to rinse off detergents or disinfectants can lead to significant irritation of the tissues of the next patient. Rinse using filtered water or high quality potable tap water.
4. **Dry: Rinse all channels with alcohol,** followed by forced dry air prior to storage (e.g. syringe with room air, assuming medical-grade air is not available).
5. **Store:** Hang endoscopes vertically to prevent recontamination and promote drying.

Clippers: Use of good-quality clippers and maintenance of clipper blades are of great importance, as their use can otherwise result in skin trauma, with subsequent risk for infection or transmission of opportunistic pathogens between patients.

Following routine use of clippers on areas of unbroken skin and non-infectious animals, **basic cleaning with a stiff brush** to remove visible dirt and hair from the blade is adequate. More thorough cleaning and disinfection of the blade, as described below, should be done periodically as well, depending on how often the clippers are used.

Thoroughly clean and disinfect clippers after every use on an animal with a potentially transmissible infection (e.g. an animal with diarrhea), on any area where the skin or hair is significantly contaminated with feces, urine, blood or other body fluids, and before and after use on an area where the skin is broken (especially if there is evidence of skin infection).

- Use a stiff brush to remove visible dirt and hair from the blade, and a soapy, wet cloth to remove any visible debris from the body of the clippers. Blades with broken teeth or that have become dull over time should be discarded and replaced.

- The clipper blade can then be sterilized using a chemical sterilant (e.g. glutaraldehyde) or by autoclaving.
- The body of the clippers can be sterilized using hydrogen peroxide vapour or ethylene oxide (if available). Otherwise, after removing all visible debris, use a disinfectant wipe or cloth wetted with a routine disinfectant solution to thoroughly wipe down the body of the clippers, paying particular attention to the small crevices of the device and allowing for adequate contact time with the disinfectant. Refer to the clipper's instruction manual to determine what degree of contact with liquid the clippers can safely withstand.

Thermometers: By virtue of their contact with the rectum, rectal thermometers are at high risk of becoming contaminated with a variety of pathogens. Measures that can be taken to reduce the risk of pathogen transmission include dedicating thermometers to individual patients, use of disposable thermometer covers, and use of proper disinfection practices. The most practical approach is to clean the thermometer to remove gross contamination, and then wipe with a disinfectant, such as an accelerated hydrogen peroxide, that is able to kill non-enveloped viruses and bacterial spores. This is unlikely to completely eliminate all pathogens but may adequately reduce contamination to reduce disease risk. Special attention should be paid to thermometers used with infectious cases. Ideally these thermometers should be discharged with the patient or discarded, however this may be impractical in many facilities. High level disinfection after such cases should be used to reduce the risk that harmful pathogens remain present on the device.

Ophthalmoscopes and other hand-held instruments: Handheld equipment such as ophthalmoscopes and otoscopes are frequently touched but may be infrequently cleaned. While their role in pathogen transmission is likely limited, routine cleaning and disinfection of these instruments (like any common hand contact surface) is indicated. There are no objective guidelines for frequency of cleaning and disinfection, but incorporating these items into a regular (e.g. weekly) schedule is logical, with additional cleaning and disinfection done on an as-needed basis after use on any potentially infectious patient. Removal of visible debris followed by wiping with disinfectant is practical for other equipment. Some items may be more difficult to disinfect based on their design (e.g. many crevices) or surface materials. These factors, and material compatibility, must be considered when selecting an appropriate disinfectant. Single-use disposable covers should be used for instruments such as tonopens when available/applicable.

Otoscope cones: While manufactured as single-use items, otoscope cones are commonly re-used in veterinary practices. Because of the contact with the ear canal, often in patients with otitis, contamination of otoscope cones is common. Cleaning must occur prior to disinfection to remove all organic material (e.g. earwax, exudates). Disinfection can be accomplished by soaking in 2% chlorhexidine solution. Chlorhexidine is primarily used as an antiseptic, but has been recommended for use with otoscope cones due to the amount of contact with the relatively bare and often sensitive skin of the ear canal. Use of a quaternary ammonium compound (QAC) or accelerated hydrogen peroxide (AHP) product would also be a reasonable choice. Ensure adequate concentration and contact times are used as per the manufacturer guidelines. Containers of standing solution/baths must also be cleaned and refreshed regularly. Regardless of the disinfectant used, cones should still be rinsed with water and dried prior to use to prevent tissue irritation from the disinfectant.

Ultrasound units and other patient-side equipment: Patient-side medical equipment can easily become contaminated with pathogens from direct contact with patients, other contaminated items, and hands of veterinary personnel. Specific recommendations are difficult to provide because of the variability in equipment surfaces, but the basic principles of cleaning and disinfection still apply:

- **Prevent contamination:** While it is impossible to prevent all contamination, the incidence and degree of contamination can be reduced by limiting direct patient contact with equipment as much as possible, using personal protective equipment (e.g. gloves) as indicated and using barriers (e.g. plastic sleeves) for high-risk (or all) cases. If the patient is harbouring a pathogen of particular concern, consider whether the procedure is truly necessary or can be postponed, particularly if the equipment cannot be reliably disinfected.
- **Clean:** Wiping equipment to remove visible contamination will greatly reduce any pathogen burden.

- **Disinfect:** Specific disinfection procedures will vary with the surface material and characteristics, but wiping with a routine environmental disinfectant is usually practical and likely effective. Consideration must be given to sensitive equipment (e.g. ultrasound probe heads) and manufacturer guidelines should be consulted with respect to compatibility with different disinfectants.

Disinfectant selection

There is no "standard" disinfection program that can be used in all veterinary clinics, as clinic environment, surfaces, caseload, general practices and other factors influence disinfectant choices. Selection of a disinfectant for a particular purpose should take into account the product's spectrum of activity, susceptibility to inactivation by organic matter, potential pathogens in the environment, compatibility with soaps and detergents, toxicity for personnel and animals, contact time required, residual activity, corrosiveness, environmental effects and cost. See Tables 6 and 7 for characteristics and antimicrobial spectrum of different classes of disinfectants. Additional information is available from various online resources (PHO 2018, Rutala 2008).

In order to simplify clinical protocols, ideally one disinfectant should be selected for routine use on most environmental surfaces and non-critical equipment. This product should have a reasonable spectrum of activity and be relatively safe to use for personnel, with minimal requirements for precautions such as ventilation, and a realistic contact time (as per manufacturer guidelines) based on its intended use. A second product should be available for periodic enhanced disinfection when there is suspicion of the possible presence of a pathogen that may not be effectively killed by the disinfectant used routinely (e.g. bacterial spores).

Disinfectant wipes: There is currently little research comparing disinfectant wipes to other disinfection methods. Proper storage is essential to prevent wipes from drying out (thereby reducing their efficacy), and to prevent the introduction of pathogens to the container. The type of disinfectant wipe must also be taken into consideration. Some disinfectant wipes are labeled as one-step, meaning they do not require a pre-cleaning step prior to use. Two-step wipes require the surface to first be cleaned with one wipe, then disinfected with a second wipe. As with any other disinfectant, product labels should be reviewed and the product deemed appropriate for use based on the selection criteria listed above.

Accelerated hydrogen peroxide (AHP): AHP products, also known as improved or enhanced hydrogen peroxide products, have become increasingly popular and more affordable since the early 2000s. This type of disinfectant is highly effective, non-toxic, and non-irritating (when appropriately diluted for use). When combined with surfactants in an acidic solution the hydrogen peroxide's microbicidal activity and cleaning efficacy are enhanced (Rutala 2012). AHPs are considered safe for the environment, people, and animals as they are biodegradable and do not leave any chemical residue on surfaces. AHPs may be used for low or high level disinfection depending on the concentration. AHPs have been shown to be effective with as little as 30-60 seconds of contact time (but as with any product, always follow the manufacturer guidelines for contact time). AHPs are also effective in the presence of limited organic material. However, AHPs can corrode soft metals such as copper, brass, and aluminum, as well as carbon-tipped instruments.

TABLE 6. Characteristics of selected disinfectants (Modified from Linton 1987, Block 2001)

Disinfectant Category	Activity in Presence of Organic Matter	Advantages	Disadvantages	Hazards	Comments
Ethyl alcohol Isopropyl alcohol (60-95% concentration)	Rapidly inactivated	Fast-acting No residue Relatively non-toxic Broad spectrum Inexpensive	Rapid evaporation Coagulates protein, inactivated by organic material May degrade plastic tubing or rubber equipment	Flammable	Not appropriate for environmental disinfection Primarily used as antiseptics
Fomaldehyde Glutaraldehyde	Good	Broad spectrum Relatively non-corrosive	Highly toxic	Irritant Carcinogenic Requires ventilation Coagulates blood, tissues	Used as an aqueous solution or as a gas (fumigation)
Ammonia	Unclear	Some efficacy against coccidial oocysts	Unpleasant odour	Do not mix with bleach Do not add water to lye Irritating Extremely caustic	Not recommended for general use
Chlorhexidine	Moderate	Non-toxic Residual activity increases with more frequent use	Incompatible with anionic detergents	May be associated with skin reactions	Not appropriate for environmental disinfection Primarily used as antiseptic
Hypochlorites (Bleach)	Rapidly inactivated	Broad spectrum, including spores Inexpensive Can be used on food preparation surfaces	Inactivated by cationic soaps/detergents and sunlight Frequent application required	Corrosive Irritant Mixing with other chemicals may produce toxic gas	Used to disinfect clean environmental surfaces Should be stored away from UV and heat
Accelerated hydrogen peroxide (AHP)	Good	Broad spectrum, including spores Environmentally friendly	Breakdown with time	May damage some soft metal surfaces	Excellent choice for environmental disinfection
Peroxygen and organic acid combo	Good	Broad spectrum	Breakdown with time (less readily than AHP)	Corrosive Potentially damaging to surfaces (e.g. concrete)	Good choice for environmental disinfection e.g. Virkon®
Phenols	Good	Broad spectrum Non-corrosive Stable in storage	Toxic to cats Unpleasant odour Incompatible with cationic and nonionic detergents	Irritant Residual film left behind; not appropriate for food surfaces	Some residual activity after drying
Quaternary Ammonium Compounds (QACs)	Moderate	Stable in storage Non-irritating to skin Low toxicity Can be used on food preparation surfaces Effective at high temperatures and pH	Incompatible with anionic detergents	Binding to gauze or cloths may reduce its delivery to target surface	Commonly used primary environmental disinfectant Some residual activity after drying

TABLE 7. Antimicrobial spectrum of selected disinfectants* (Modified from Linton 1987, Block 2001)

Most susceptible

Susceptibility of microorganisms to chemical disinfectants

Most resistant

Agent	Ethyl alcohol Isopropyl alcohol	Formaldehyde	Ammonia	Chlorhexidine Chlorhexidine	Hypochlorite Bleach	AHP, Peroxygen	Phenols	Quaternary Ammonium Compounds
Mycoplasmas	++	++	++	++	++	++	++	+
Gram-positive bacteria	++	++	+	++	++	++	++	++
Gram-negative bacteria	++	++	+	+	++	++	++	+
Pseudomonads	++	++	+	±	++	++	++	±
Enveloped viruses	+	++	+	++	++	++	++	+
Chlamydiae	±	+	+	±	+	+	±	-
Non-enveloped viruses	-	+	±	-	++	+	±**	-
Fungal spores	±	+	+	±	+	±	+	±
Acid-fast bacteria	+	++	+	-	+	±	++	-
Bacterial spores	-	+	±	-	++	+	-	-
Coccidia	-	-	+	-	-	±	+	-

++ Highly effective; + Effective; ± Limited activity; - No activity

Examples of microorganisms from each category:
Mycoplasmas: *Mycoplasma canis, Mycoplasma felis;* **Gram-positive bacteria:** *Staphylococcus* spp, *Streptococcus* spp; **Gram-negative bacteria**: *Bordetella bronchiseptica, Salmonella* spp; **Pseudomonads:** *Pseudomonas aeruginosa;* **Enveloped viruses:** influenza virus, herpesvirus; **Chlamydiae:** *Chlamydophila psittaci;* **Non-enveloped viruses:** feline panleukopenia virus, canine parvovirus; **Fungal spores:** *Blastomyces dermatitidis, Sporothrix schenckii;* **Acid-fast bacteria:** *Mycobacterium avium;* **Bacterial spores:** *Clostridium difficile, Clostridium perfringens;* **Coccidia:** *Cryptosporidium parvum, Isospora* spp, *Toxoplasma gondii.*

*These are intended to be general guidelines for the selection of an appropriate disinfectant. Product labels should always be consulted prior to use to ensure that the efficacy claims are appropriate for the intended purpose.

**In general, phenols are not effective against non-enveloped viruses, but they have been found to be effective against rotaviruses, such as equine rotaviral disease in foals. However, efficacy against small animal parvoviruses has not been demonstrated (Bailey 2013, Stuetzer 2014).

Sterilization

Sterilization involves destruction of all viable microorganisms, including hardy forms such as bacterial spores (Rutala & Weber 1999) and is used for critical items that may come into contact with sterile tissue or the bloodstream (Rutala & Weber 1999, 2009) such as surgical equipment, intravenous catheters and urinary catheters. Sterilization can be achieved through dry heat, steam under pressure, chemical vapours or liquid immersion. Different methods are appropriate for different items and material types. Some of the recommendations below are considered minimum standards in various jurisdictions (e.g. use of autoclave sterilization). Veterinarians should contact their local veterinary regulatory body for details about specific regulations.

Preparation

Items undergoing sterilization must be **clean**. Items that are grossly contaminated (e.g. blood stained) should be considered non-sterile even if they have undergone a sterilization process, as the contamination can physically interfere with the sterilization process.

Specific pre-sterilization cleaning protocols depend on the type of item, manufacturer cleaning recommendations and the degree of contamination. Typically, items are wiped or rinsed to remove gross contamination followed by cleaning with a product to help remove smaller debris, fats, oils and grease. Detergents, enzymatic cleaners and proteolytic products (or combinations thereof) may be used depending on the situation. Detergents help break down oils, fats and grease to facilitate removal and are likely appropriate for most equipment, excluding those coated in organic debris. Enzymatic products are typically used to soak instruments that have dried-on blood or other organic debris, including surgical instruments, and/or instruments with crevices that are hard to clean. Proteolytic products help remove adherent proteins. There is little objective guidance for optimal cleaning practices. After cleaning, items should be rinsed with potable water to remove residual debris and the cleaning agent, since some cleaners may damage surfaces with prolonged contact, and some may be incompatible with chemical disinfectants that are subsequently used.

In veterinary hospitals, most cleaning is done by hand. This is an acceptable approach and it should be performed in a designated clean area (e.g. not in a sink that is likely to be grossly contaminated) and where re-contamination during drying is unlikely. A dedicated sink for reprocessing is ideal. Automated washing machines (e.g. dishwashers, cart washers, specific equipment washers) can be effective and efficient for the purposes of cleaning but must be maintained properly. While some machines have “sanitize cycles”, these should not be considered equivalent to disinfection because of the inability to adequately monitor temperature, contact time and surface coverage.

Instruments should be broken down or disassembled and/or left in the open/unlocked position during sterilization to maximize efficacy of whatever method is used. It is also important not to over pack instruments or attempt to sterilize too many packs in a single load, in excess of the manufacturer’s recommendations.

Sterilization methods

TABLE 8. Sterilization methods*

Approach	Description	Advantages	Disadvantages
Steam/ Autoclave	• Steam sterilization kills through a combination of steam, pressure, temperature and time, with ideal conditions being 100% dry saturated steam with no water (e.g. no mist). • Pressure allows for generation of higher temperatures to more rapidly kill microorganisms • 121ºC for 30 minutes in a gravity displacement autoclave is commonly used • Considered minimum standard for veterinary clinics in some jurisdictions	• Relatively easy • Cost effective • Non-toxic • Dependable	• Not all materials can withstand autoclaving
Immediate-use steam sterilization ("flash" sterilization)	• Process whereby an item is autoclaved in a more rapid manner immediately before use on the patient. • Typical conditions are 132ºC for 3 minutes and 27-28 pounds of pressure with an unwrapped item in a gravity displacement autoclave • Items are generally not wrapped and therefore processed near the patient area where they will be used immediately following sterilization • Most commonly used when an item is dropped during surgery and no sterile replacement is available. • It is also acceptable for items that cannot be packaged, sterilized and stored before use (rare in veterinary clinics) • **Not recommended for routine/general use.**	• Fast	• Less reliable than other methods • Has been associated with SSI and patient burns from hot instruments • Never use for surgical implants
Dry heat	• Uncommonly used • Conditions include 170ºC for 60 min, 160ºC for 120 min or 150ºC for 150 min	• Acceptable for materials that might be damaged by moisture or are impenetrable to moist heat • Non-corrosive	• Long cycle time
Ethylene oxide	• Kills microorganism through alkylation of protein, DNA and RNA • Typical recommended conditions are 450-1200 mg/ml, 29-65ºC, 45-85% and 2-5hr	• Can be used to sterilize items that cannot withstand steam sterilization • Broad spectrum activity against even hardy organisms like mycobacteria, enveloped viruses and bacterial spores	• Cycle time • Cost • Health and safety concerns (chemical is flammable, explosive and toxic) • May be regulatory rules regarding use in some jurisdictions

Approach	Description	Advantages	Disadvantages
Hydrogen peroxide vapour	• Relatively new approach that takes advantage of the broad antimicrobial activity of hydrogen peroxide • Rarely used outside of commercial industry	• No toxic by-products (hydrogen peroxide breaks down to water and oxygen) • Relatively short cycle time • Compatible with a wide range of materials • Can effectively penetrate lumens with small internal diameters or long length	• Expensive
Liquid immersion / cold sterilization	• Involves the use of one of several commercially available chemical sterilants • When used properly, true sterilization can be achieved, but more often used for high-level disinfection • Should be reserved for items that cannot be processed using other methods • The time required to achieve sterilization is typical 3-12 hours (follow manufacturer guidelines) • Items typically need to be rinsed with sterile water or saline (if sterility must be maintained) before being used on patients	• Can be used to sterilize items that cannot withstand steam sterilization (e.g. endoscopes)	• More dependent on thorough cleaning than other sterilization methods • Prone to processing errors (e.g. improper dilution, inadequate contact time, improper pH, failure to ensure no air pockets are present) • Solutions are typically quite toxic and require long contact time and careful management. • Items typically cannot be packaged and stored in a sterile manner after removal from the solution

*always refer to manufacturer recommendations for use of specific equipment and products

"Cold sterile" solutions in veterinary clinics: In some veterinary clinics, disinfectant solutions of various kinds in which a set of instruments is routinely kept are frequently referred to as "cold sterile." Such misuse of this term should be avoided, as instruments kept in such disinfectant solutions are not sterile, and therefore should not be used for surgical or other invasive procedures in which they may come in contact with sterile tissue. True cold sterilization requires use of a chemical sterilant product, meticulous cleaning of all instruments prior to immersion, and careful management of the solution itself to ensure that adequate concentration and contact time are achieved. If clean, non-sterile instruments are periodically required for minor procedures, these should not be kept in a disinfectant solution, but rather in a clean, dry, closed container. Once used, instruments should only be returned to the container after they have been thoroughly cleaned, undergone at least low-level disinfection (or higher depending on intended use as per Spaulding criteria, see Table 3), and completely dried.

Glass bead sterilizers, which are sometimes used in laboratory settings when performing multiple procedures on rodents in series, should not be used for quick sterilization of instruments in clinical practice, as these devices only sterilize the tip of the instrument and increase the risk of thermal tissue damage due to use of hot instruments.

Assessment of sterilization – Autoclaves

Quality control testing of autoclaves should be performed regularly and documented. For other methods of sterilization, consult the equipment manufacturer regarding specific means and frequency of quality control testing required.

- **Internal indicator strips** should be placed in every surgical pack prior to autoclaving. External autoclave indicator tape is not a reliable indicator of the sterility of a pack's internal contents. The external indicator tape should be evaluated by the individual removing packs from the autoclave, and the internal indicator strip should be evaluated by the individual opening the pack at the time of use.
- **Biological sterility indicators** should be used periodically. These indicators contain bacterial spores, which are the most resistant form of bacteria. After being autoclaved, the indicator is placed in a small bench-top incubator to ensure that all of the spores have been killed by the sterilization process. In human healthcare facilities it is recommended that these indicators are used daily. Weekly or bi-weekly use is likely adequate in most veterinary clinics, depending on how heavily the autoclave is used. A biological sterility indicator should also be used in the first cycle after the autoclave has been moved, repaired, or if there has been any indication of sterilization failure.

If internal or external indicators fail, the items in question must not be used and the event investigated immediately. In the event of biological indicator failure (with or without external or internal indicator strip failure), any implantable items (e.g. fixation plates, pins, screws) sterilized after the last biological indicator was tested and passed must be immediately recalled. Recall of other items is prudent but not considered necessary while the investigation is underway. Three more consecutive autoclave runs should be performed with biological indicators, and if any are positive, then all items processed since the last successful biological indicator run must be recalled and re-processed (Rutala 2017).

With any possible autoclave failure, the autoclave should be promptly serviced by certified personnel. Biological indicator results should be recorded in an autoclave log to allow for tracking of autoclave function. Autoclaves should be serviced regularly by certified personnel as part of a preventive maintenance schedule.

Labeling and storage

Label sterilized items with the date of sterilization, and ideally also the load number, to allow for removal of items of concern if problems are identified at a later date and for consideration of shelf-life. Do not write on the paper side of packaging if peel pouches are used, due to the risk of compromising package integrity. Store sterilized items in well ventilated areas that prevent accumulation of moisture, dust and extremes in temperature and humidity (Rutala & Weber 2009). Items should be minimally handled after sterilization to decrease the risk of unapparent damage to the packaging. Formal expiry times are not available for autoclaved items, however, one year is a reasonable limit for items that are stored and handled properly. Transportation of sterilized items between facilities is discouraged because of the potential for damage or loss of packaging integrity during transportation and handling.

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