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G1410

Selection and Use of Disinfectants

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This NebGuide provides cattle producers and animal health workers information to help them better select and use disinfectants in their biosecurity program.

It is important to note that selecting and using disinfectants is only a tool in achieving the goal of biosecurity, which is to prevent, minimize or control cross-contamination of infective organisms between animals, from animals to feed and from animals to equipment that may directly or indirectly contact animals.

Definitions

Antiseptic — chemicals used to inhibit or prevent the growth of microbes on living tissue

Disinfectant — chemicals used to inhibit or prevent the growth of microbes on inanimate objects

Sanitize — reduce the number of microbes to a safe level

Sterilize — eliminate all microbes (inactivates or kills)

Bactericide — kills bacteria

Fungicide — kills fungi

Viricide — kills virus (enveloped/lipophilic are typically easier to kill than nonenveloped viruses)

Sporicide — kill spores (fungi and bacteria)

Biocide — kills living organisms

Bacteriostat — inhibits the growth of bacteria

Detergent — contains free ions (leaves film on surface)

Anionic Detergent — (soaps) have free negative ions that produce curd when combined with calcium and magnesium in hard water

Cationic Detergent — Quaternary ammonium contains positively charged ions which remain suspended in solution

Selection

Usually disinfectants are "cidal" in that they kill the susceptible potential pathogenic agents. The selection of a disinfectant should be based on the job you expect the disinfectant to do, not necessarily on a sales pitch or on what you have always used. Ideally, select a disinfectant that is broad spectrum (eliminates bacteria, viruses, protozoa, fungi and spores) and is nonirritating, nontoxic, noncorrosive and inexpensive. Selection decisions should include effectiveness against the potential pathogenic agent, safety to people/animals, impact on equipment, the environment, and expense.

Disinfectant effectiveness depends on many factors. These include:

1. Type of contaminating microorganism. Each disinfectant has unique antimicrobial attributes.
2. Degree of contamination. This affects the time required for disinfection and the amount of chemical required.
3. Amount of protein-containing material present. Protein based materials absorb and inactivate some chemical disinfectants.
4. Activity in organic matter and other compounds such as soaps.
5. Type of chemical. It is important to understand the mode of action in order to select the appropriate disinfectant.
6. Concentration and quantity of chemical. It is important to choose the proper concentration and quantity of chemical that are best used for the disinfection of each situation.
7. Contact time and temperature. Sufficient time and appropriate temperature, which is proportional to the degree of contamination, must be allowed for action of the disinfectant.
8. Residual activity and effects on fabric and metal.
9. Application temperature, pH and interactions with other compounds must be considered.
10. Toxicity to the environment and relative safety to animals that may be exposed.
11. Cost.

Types of Disinfectants Considered

Chlorine Iodophors	Chlorhexidine	Alcohols
Peroxide Phenols	Quaternary ammonia	Aldehydes

Hypochlorites

Chlorine disinfectants as well as iodine disinfectants belong to the halogen group. Chlorine eliminates both

enveloped and nonenveloped viruses. Chlorine also is effective against fungi, bacteria, and algae. Chlorine is not effective against spores. Household bleach (5.25 percent NaClO), a common source, is cheap and readily available. It is typically diluted using 1:128 to 1:32 with water (1/8 to 1/2 cup per gallon of water).

Chlorine disinfectants corrode metals and deteriorate fabrics. Chlorine in high concentrations irritates the mucus membranes, eyes and skin. Organic material such as feces inactivate chlorine disinfectants, therefore, surfaces must be clean before using a chlorine disinfectant. In order to obtain maximum results with chlorine disinfectants they must remain in contact with surfaces for several minutes. A 50 percent stock bleach (2.125 percent) will reduce the infectivity of disinfectant resistant protozoa such as Cryptosporidium. The pH of the water used for dilution should be between 6 and 8 to be effective. The effectiveness decreases when application temperatures are below 65 degrees. Decreasing the temperature to 50 degrees cuts the effectiveness in half. Chlorinating drinking water for cattle should not exceed 6 to 10 ppm. Use the lower value in continuous flow or low volume reservoir systems.

Summary:

1) Provide wide germicidal activity and are relatively nontoxic
2) Limited activity when in the presence of organic matter
3) Poor residual activity and corrosive
4) Fair effectiveness as sporicidal agents
5) Effective at low concentrations for disinfecting objects
6) Low cost, but requires frequent applications

Iodine and Iodophor Disinfectants

Iodine and iodophors are simply chemical compounds. These compounds can be included in a time release formulation and with soaps (surgical scrubs). Simple iodine tinctures (iodine + R-OH) do not contain a cleaning compound. Iodine and iodophors are bactericidal, sporicidal, virucidal and fungicidal. Iodine, like chlorine, is inactivated in the presence of organic material and they must be applied multiple times in order to thoroughly disinfect. Iodine tinctures can be very irritating to tissues, can stain fabric and be corrosive. “Tamed” iodines such as surgical scrubs and surgical disinfectants generally do not irritate tissues. Tamed iodines include Betadyne, Povidone, Wescodyne, Virac and Prepodyne. Others include One Step and Iosan.

Summary:

1) Provide wide germicidal activity and are relatively nontoxic
2) Limited activity when in the presence of organic matter
3) Poor residual activity, corrosive, stains fabric and equipment
4) Fair effectiveness as sporicidal agents, but better than chlorine
5) Effective at low concentrations for disinfecting objects
6) Low cost but requires frequent applications

Chlorhexidine

Chlorhexidine, a biguanide, is one of the more widely used disinfectants. Chlorhexidine is relatively nonirritating to tissues. Chlorhexidine, while considered bactericidal, virucidal and fungicidal, is less effective against these agents than many other disinfectants. Chlorhexidine maintains effectiveness in the presence of some organic material, but cleaning before application is recommended. To be effective chlorhexidine must remain in contact with the surface for at least five minutes. Hard or alkaline water will cause precipitation of the active ingredients necessary for disinfection. Chlorhexidine disinfectants include Nolvasan, Chlorhex, Chlorasan, Virosan, Hibistat Phisohex.

Summary:

1) Wide germicidal activity, but ineffective against some important species
2) Some activity in the presence of organic matter
3) Some residual activity but must be in contact for at least five minutes
4) Fair effectiveness as sporicidal agents
5) Effective at low concentrations for disinfecting objects
6) Low cost but requires frequent applications
7) Nontoxic

Alcohols

Alcohols are commonly used topical disinfectants. They are effective against Gram + and Gram – bacteria, and enveloped viruses. Alcohols are not effective against bacterial spores and nonenveloped viruses. Alcohols require time to work and they do not penetrate organic material. Alcohol irritates tissues and denatures protein which may promote bacterial growth in open wounds. They are too expensive for general use.

Summary:

1) Wide germicidal activity, noncorrosive, poses a fire hazard and irritating to tissues
2) Limited activity in the presence of organic matter and limited residual activity
3) Not effective against bacterial or fungal spores
4) Excellent when used at 70-95 percent concentration for disinfecting instruments, etc.

Oxidizing Agents

Peroxides such as hydrogen peroxide are often used to clean wounds. The activity of peroxides is greatest against anaerobic bacteria. Hydrogen peroxide is not virucidal and in some cases is damaging to tissues, resulting in a prolonged healing time. Hydrogen peroxide is useful for cleaning surgical sites after closure, but use sparingly to avoid penetrating suture lines which would inhibit healing.

Blended and/or stabilized peroxides can be used to disinfect equipment surfaces. Stabilized peroxides may be blended with iodophors or quaternary ammonia. Some products are effective against a much broader range of pathogens including both enveloped and nonenveloped viruses, vegetative bacteria, fungi and bacterial spores. Examples include Hyperox and VirkonS.

Summary:

1) Moderate to wide germicidal activity, moderately corrosive and limited toxicity
2 Rendered ineffective in the presence of organic matter
3) Poor to limited residual activity
4) Not effective against bacterial or fungal spores
5) More valuable as a cleansing and deodorizing agent and are moderate in cost

Phenolic Disinfectants

Phenol is commonly found in mouth washes, scrub soaps and surface disinfectants, and is the main disinfectant found in household disinfectants. Phenols are effective against bacteria (especially gram positive bacteria) and enveloped viruses. Phenols are not effective against nonenveloped viruses and spores. Enveloped viruses include BRS, BVD, Coronavirus, IBR, Leukemia, PI3, Pox, Rabies and Stomatitis virus. Nonenveloped viruses include Bluetongue, Papilloma, Parvo and Rota virus. Common spore forming bacteria of cattle include all the clostridias (such as tetanus) and bacillus (such as anthrax).

Phenols maintain their activity in the presence of organic material and therefore are more useful in foot baths and areas which organic material cannot be completely removed. Phenolic disinfectants (including cresols and pine oil) are generally safe, but prolonged exposure to the skin may cause irritation. Phenolic disinfectants include O-Syl, Matar, Septicol, Hexachlorophene, Environ, One-Stroke, Lysovet, Tek-Trol, Lysol, Pantek, Discan, Pine-sol and Staphene.

Summary:

1) Wide germicidal range, relatively noncorrosive and limited toxicity
2) Very effective in the presence of organic matter
3) Poor to limited residual activity
4) Not sporicidal
5) Typically effective as a deodorizer and are of low to moderate cost

Quaternary Ammonium Compounds

Quaternary ammonium (QA) disinfectants contain NH4. The labels often list a form of ammonium chloride (AC) such as alkyl aryl, benzyl, didecyl, dimethyl, ethylbenzyl, octyl or a combination of different AC. Benziconium chloride (BC) is a more tissue friendly QA than AC. QA disinfectants are effective against Gram + and Gram - bacteria, and enveloped viruses. They are not effective against non-enveloped viruses, fungi and bacterial spores. QA compounds bind to organic material including soaps so the area to be disinfected must be cleaned and rinsed free of soap. Extremely hard water also deactivates QA disinfectants. QA compounds are generally low in toxicity, but prolonged contact can be irritating. QA disinfectants include Roccal, Quats, Lysoquat, Multi-Quat, TKO, Utmost, D-128 and Zephiran.

Summary:

1) Wide germicidal range, noncorrosive and low toxicity
2) Reduced efficiency and residual activity in the presence of organic matter
3) Not sporicidal, effective against vegetative bacteria, fungi and viruses, some activity against Cryptosporidium (10 percent Ammonium)
4) Limited effectiveness in soaps, detergents and hard water salts
5) Good disinfectant for use on cleaned surfaces and low cost

Aldehydes

Aldehydes have a wide germicidal spectrum. Glutaraldehydes are bactericidal, virucidal, fungicidal, sporicidal and parasiticidal. They have a moderated residual activity and are effective in the presence of moderate organic material.

Glutaraldehyde disinfectants include Lysofume and Wavicide-I / Wavicide-06. Formaldehydes are very potent disinfectants, but can be highly toxic to people and animals. Use them only as a last resort and then under trained supervision in a well ventilated setting. Formaldehyde has shown effectiveness against cryptosporidiosis.

Summary:

1) Wide germicidal activity is both sporicidal and fungicidal, effective against protozoa, is moderately toxic and poses a human health risk if improperly used
2) Slight to moderate efficiency in presence of organic matter
3) Slight residual activity
4) Most of these products are moderately expensive

Disinfectant Selection Table

Compound	*Chlorine 0.01-5%*	*Iodine Iodophor 0.5-5%*	*Chlorhexidine 0.05-0.5%*	*Alcohol 70-95%*	*Oxidizing 0.2-3%*	*Phenol 0.2-3%*	*Quaternary Ammonium 0.1-2%*	*Aldehyde 1-2%*
Examples	Clorox	Tincture / Provodine	Novalsan		VikronS	Lysol	Roccal-D	Wavicide
Bactericidal	Good	Good	Very Good	Good	Good	Good	Good	Very Good
Virucidal	Very Good	Good	Very Good	Good	Good	Fair	Fair	Very Good
Envelope Viruses	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Non-Envelope Viruses	Yes	Yes	No	No	Yes	No	No	Yes
Bacterial Spores	Fair	Fair	Poor	Fair	Fair-Good	Poor	Poor	Good
Fungicidal	Good	Good	Fair to Good	Fair	Fair	Good	Fair	Good
Protozoal Parasites	Fair strong Conc	Poor	Poor	Poor	Poor	Poor	Fair (Ammonia)	Good
Effective in Organic Matter	Poor	Fair	Fair	Fair	Poor	Good	Poor	Good
Inactivated by soap	No	No and Yes	No	No	No	No	Yes	No
Effective in Hard water	Yes	No	Yes	Yes	Yes	Yes	No	Yes
Contact Time (minutes)	5-30	10-30	5-10	10-30	10-30	10-30	10-30	10-600
Residual activity	Poor	Poor	Good	Fair	Poor	Poor	Fair	Fair

Cattle Viruses With and Without Viral Envelopes

Virus	*Envelope*	*Virus*	*Envelope*	*Virus*	*Envelope*
Bluetongue	No	Malignant Catarrhal Fever	Yes	PI3	Yes
Rotavirus	No	Enteric Coronavirus	Yes	Rabies	Yes
Papillomatosis	No	Resp Coronavirus	Yes	Herpes Mammillitis	Yes
Leukemia	Yes	BVD	Yes	Cowpox	Yes
Papular Stomatitis	Yes	BRSV	Yes	Pseudocowpox	Yes
Vesicular Stomatitis	Yes	IBR / IPV	Yes	Lumpy Skin Disease	Yes

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