Use of disinfectants in zoos and game parks

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Summary: Disinfection is used in the animal quarters of zoos and game parks as an adjunct to physical cleaning and the removal of potentially contaminated materials. Disinfection is particularly useful in reducing infection risks in young animal nursery facilities, and in routine cleaning operations of animal quarters and feeding utensils. Specific disinfectants may be selected for certain known microbial contaminants following an infectious disease outbreak. For example, premises contaminated by foot and mouth disease virus are usually disinfected with 2% sodium hydroxide (lye).

The disinfectants most commonly used in zoo operations usually have a broad spectrum of microbicidal activities, such as o-phenylphenol salts, especially sodium o-phenylphenol. Equally popular for routine cleaning and sanitizing operations in zoos are quaternary ammonium compounds and chlorine bleach (sodium hypochlorite).

It is important to remember that many disinfectants are protoplasmic poisons, or may be caustic or corrosive. Animals must usually be excluded from facilities being disinfected and premises should be rinsed thoroughly, after a suitable environmental exposure time to such disinfectants, before animals are allowed to return.


INTRODUCTION

Sanitation and hygiene are essential components of a preventive animal and human health programme for zoos, game parks or any livestock operations (5, 9). As with livestock, the use of disinfectants in captive wild animal collections can contribute greatly to the prevention, control and containment of infectious diseases. However, the use of disinfectants cannot be expected to substitute for good sanitary and hygienic practices (e.g. washing of hands, and routine cleaning of animal quarters, enclosures, feeding and food handling containers, implements and equipment). Disinfection can serve as a supplementary tool in reducing the risk of both animals and humans being exposed to pathogenic microorganisms. Information is given below on the disinfectants commonly recommended and used in zoos and game parks, and the correct means of application for environmental disinfection. Disinfection – i.e. the freeing of inanimate objects and materials from infection – is accomplished in a zoo setting by using both physical and chemical agents (1). The choice of disinfectants depends on the practical conditions under which they are to be used and the infectious agents likely to be present (8, 13).

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CHOICE OF DISINFECTANTS

Physical agents

Heat

Heat is often used to disinfect and sterilize surgical and medical instruments, and sometimes feeding containers, especially when these are likely to be contaminated with infectious agents in a zoo hospital. Moist heat – delivered under pressure in a steam sterilizer (autoclave) – is highly effective in destroying most infectious agents, with the exception of the agents (referred to as ‘prions’) of scrapie, bovine spongiform encephalopathy and mink encephalopathy (7, 13).

Zoos often use a steam cleaner (‘steam jenny’) for the cleaning and preliminary disinfection of animal enclosures, housing and sleeping quarters. This method is particularly efficacious of this procedure for cleaning greasy areas, but rapid cooling on surfaces limits the antimicrobial efficacy of this procedure (13). For best results, the steam discharge head must be held within 2-4 in. (5-10 cm) of the surface being cleaned. Incineration of contaminated carcasses, bedding, litter and food-stuffs is another obvious application of heat for terminal disinfection.

Light

Exposure of an outdoor enclosure to sunlight for a period of several weeks to three months may be sufficient to eliminate many infectious agents, especially on non-porous surfaces. Ultra-violet light from the sun and artificial sources has been found to be most effective against Gram-negative and non-sporulating bacteria, while staphylococci, streptococci and some viruses are resistant (7).

Washing

Preliminary physical cleaning of hard-surfaced enclosures and cages is often accomplished using a high-pressure water jet. This is sometimes accompanied or followed by the use of soaps or detergents, some of which may have disinfectant properties as well as cleansing action (5).

Soaps

Soaps are sodium or potassium salts of fatty acids (e.g. oleic, palmitic and stearic acids). Soaps are inactivated in the presence of calcium or molybdenum ions. Although soaps are not antibacterial, the cleansing action removes large numbers of microorganisms. After cleaning with soaps, feeding utensils and containers must be thoroughly rinsed, as soap residues can be toxic if ingested in large quantities, producing severe gastritis and fatal collapse (5).

Synthetic detergents

Cationic detergents are usually sulfate or sulfonate salts made from animal and vegetable fats or petroleum compounds. These substances are popular cleansing substances, as they are not affected by hard water. Cationic detergents have minimal disinfectant action against vegetative bacteria, and are ineffective against viruses, fungi and spores (5).

Chemical agents

In a routine cleaning and disinfection programme, disinfectants should be applied after physically cleaning the animal facility by removal of faeces, urine, unconsumed
food and other debris. If the enclosure is known to be contaminated with a very serious, highly infectious disease agent – especially one which also affects humans (i.e. a zoonotic disease agent) – then the enclosure should be sprayed with a suitable disinfectant before cleaning. The presence of large amounts of organic material rapidly reduces the efficacy of a number of chemical disinfectants. Further details are presented below.

**Halogen**s

**Chlorine compounds**

Chlorine usually occurs in nature in combination with sodium, potassium, calcium or magnesium. A great number of antimicrobial chlorine compounds are commercially available (4). Chlorine compounds are used in zoos for water purification (e.g. in pools for aquatic animals) and for general sanitation, as disinfectants and deodorizers (5).

**Sodium hypochlorite**

Sodium hypochlorite (common household bleach) is probably the most popular and most cost-effective sanitizer and disinfectant used in zoos and game parks for the treatment of pools, enclosures and feeding utensils and containers. In this last usage, sodium hypochlorite is often combined with cationic detergents. Commercial chlorine bleach products usually contain 5.25% sodium hypochlorite in aqueous solution; for use in disinfection, a 5% dilution of household bleach is commonly used (giving a final solution concentration of approximately 0.25% sodium hypochlorite). Sodium hypochlorite is a powerful germicide, controlling a wide spectrum of microorganisms (4). The disinfectant action of the chlorine solution is decreased by the presence of organic matter. Hypochlorite solutions therefore work most effectively on cleaned surfaces, although they can also aid in the removal of organic material. As hypochlorites are strong oxidizing and bleaching agents, tend to corrode metals and have a very strong odour, they are not recommended for use in closed food storage compartments (e.g. refrigerators and freezers) (7).

**Chlorinated lime**

Chlorinated lime (also known as bleaching powder) is a mixture of calcium hypochlorite and calcium chloride. This mixture is highly irritant and must be handled very carefully, as it releases poisonous chlorine gas; it should therefore be handled only in well-ventilated rooms or outdoors. Chlorinated lime is a practical and effective disinfectant, which is able to destroy disease organisms in organic matter (7). Areas disinfected with chlorine compounds must be well ventilated and should be rinsed well after a suitable exposure period (usually 30-60 min) to prevent animals being exposed to toxicity from residues.

**Iodine compounds**

Inorganic iodine solutions, especially tinctures (alcohol solutions), have been used for many years as antiseptics, particularly for topical application on minor wounds. However, only since the development of iodophors (‘tamed’ or organic iodine) has iodine become a practical, effective disinfectant. Iodophors are most commonly used to sanitize dishes for food and water, surgical instruments, and for pre-surgical skin cleansing. As iodophors are more expensive than hypochlorites, they are not in general use for environmental disinfection (5, 6).
Coal tar derivatives

Phenol

Phenol is a general protoplasmic poison – a 5% concentration kills anthrax spores – and is also one of the best anti-tubercular disinfectants (7). Unfortunately, concentrations of phenol exceeding 2% are highly toxic for all species of animals, especially cats. Other disadvantages of phenol include inefficacy against certain forms of bacteria, and a strong odour which is absorbed by foods (5, 7, 12).

Cresol

Cresols are phenolic compounds which have a methyl group substituted for one hydrogen atom on the benzene ring. Cresol is more bactericidal but less toxic and caustic than phenol; it is also less expensive (5, 7). As cresol is relatively insoluble in water, it is saponated for use: 50% cresol with approximately 35% soap and 15% hydroalcoholic diluent. Saponated cresol readily mixes with soft (but not hard) water in all proportions to form a soapy solution, and is generally used in a 2% solution; it should be applied hot when disinfecting animal quarters and premises. A pressure sprayer provides the easiest and best means of application. Cresols cannot be used where human foods are stored, as the phenolic odour is absorbed by foodstuffs.

Sodium o-phenylphenol

Sodium o-phenylphenol is recognized as an official disinfectant in the United States of America and some other countries, primarily as it is effective against the causative bacteria of tuberculosis (7). Preparations of this phenolic compound have broad application as general disinfectants. It is most effective when used hot as a 1% aqueous solution. Some commercial preparations combine sodium o-phenylphenol with detergents. Sodium o-phenylphenol is excellent for use against staphylococci, pseudomonads, mycobacteria, fungi, most viruses (especially lipophilic viruses) and many metazoan parasites (e.g. ascarids, strongyles, trichurids) (5, 7). As with other phenolics, o-phenylphenols are corrosive to tissue. Animals should therefore be removed from quarters during the disinfection process. The use of goggles and rubber gloves is recommended when applying this group of disinfectants (5, 7).

Other disinfectants commonly used in zoos

Quaternary ammonium compounds

Quaternary ammonium compounds (QACs) vary greatly with respect to recommended applications and use concentrations. They are frequently used as general disinfectants. QACs are highly stable, odourless and colourless, and are effective against Gram-positive and Gram-negative organisms. They are not sporicidal, fungicidal or virucidal and are inactivated in the presence of organic matter. When used as recommended, QACs are non-toxic; but high concentrations produce respiratory paralysis. QACs in aqueous and alcoholic solutions are applied directly to tissues for wound disinfection, and are also used as sanitizing rinses for eating and drinking utensils after organic material has been removed. The exterior of eggshells may also be sanitized with QACs, as they are highly germicidal at alkaline pH. QACs are not suitable for disinfecting animal quarters or premises, as they would be rapidly neutralized by the large amount of organic debris which is usually present (5, 7, 11).

Benzalkonium chloride may be used in aqueous solution at concentrations of 1:2,000-1:10,000 for general disinfection of intact skin and mucous membranes, and also for treatment of superficial injuries and infected wounds. A tincture (1%) may be used
for pre-surgical disinfection of intact skin or treatment of wounds. A concentration of 1:1,000 is recommended for storage of sterile instruments and rubber articles. However, a lower concentration of 1:20,000 is recommended for disinfection of catheters (soaking for 15-30 min). A 10% aqueous solution of benzalkonium chloride is commercially available for general disinfection purposes.

Benzethonium chloride and cetlypyridinium chloride are similar to benzalkonium chloride, but their use is less common. Careful attention must be paid to the instructions given on the label of any of these compounds; this applies to all drugs (7).

**Sodium hydroxide**

Sodium hydroxide (lye) in a 2% aqueous solution is the disinfectant of choice for contaminated premises after an outbreak of foot and mouth disease. When spraying lye, operators should wear a protective face mask, or shield and respirator, as well as rubber head covering, clothing, gloves and boots. Lye should be rinsed off with water after a minimum exposure time of 1 h, as it is relatively caustic and toxic. Animals must be removed from an enclosure before lye disinfection is performed (5, 7).

**Formalin and formaldehyde**

Formalin is a 40% solution of formaldehyde gas in water. It has limited application in zoo disinfection, due to corrosive, toxic and carcinogenic properties. However, formalin may be used as a fumigant (through the release of formaldehyde gas) to sterilize incubators used for wild bird eggs. Formaldehyde fumigation may also be used to disinfect buildings. For these purposes, 60 g potassium permanganate (KMnO₄) is placed in a ceramic or metal beaker or other vessel and is then covered with 120 ml formaldehyde solution for each 100 cubic ft (2.8 m³) of space (incubator, room or building) to be treated. Personnel performing this procedure must wear an appropriate respirator and protective clothing. A building thus fumigated should be kept closed and sealed for at least 24 h (13). Before allowing entrance, the premises should then be well ventilated for 1-2 h until free from any detectable formaldehyde odour. Formaldehyde used in this way will kill *Mycobacterium* spp., as well as most other bacteria, viruses and fungi (7, 14).

**Hydrogen peroxide**

Hydrogen peroxide is not useful for environmental disinfection, but is invaluable for cleansing, removing exudate, and deodorizing infected tissue and open wounds (2, 7).

**Alcohols**

Alcohols, like peroxides, are seldom used for environmental surface disinfection, but are more commonly used as antiseptics on skin, sometimes in combination (tinctures) with other chemicals, such as iodine and QACs. Alcohols have significant antibacterial action against vegetative bacterial cells but, like many other disinfectants, do not destroy spores, some fungi and many viruses. Ethyl alcohol is generally considered one of the best antiseptics available, and is commonly used in a dilution of 78% by weight or (70% by volume) for topical disinfection of tissues (e.g. prior to surgery) (7, 10).

**Chlorhexidine**

Chlorhexidine is another chemical which is often used for skin antisepsis (e.g. pre-surgical hand disinfection and final-stage preparation of a surgical site). It is an effective virucide, and is especially useful in disinfecting inanimate objects which may be
contaminated with rabies virus. Chlorhexidine is relatively ineffective against Gram-positive bacteria and pseudomonads. A use concentration of 30 ml per 4 l of water is recommended (3).
en particular el o-fenilfenolato de sodio. Los amonios cuaternarios y el hipoclorito de sodio pueden también usarse en las operaciones de limpieza de rutina y de saneamiento en los jardines zoológicos.

Conviene recordar que muchos desinfectantes son venenos protoplásmicos y que pueden ser cáusticos o corrosivos. Normalmente, se hace salir a los animales de los locales por desinfectar y, antes de reintroducirlos y tras haber dejado actuar convenientemente los desinfectantes, es conveniente enjuagar a fondo los locales.


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REFERENCES


