History and future perspectives of the use of disinfectants in animal health

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Summary: Programmes for the prevention, control and eradication of animal diseases are closely interlinked in many ways. In the field of animal health over the last 100 years, surveillance, diagnostics, rapid response, regulatory and legal authorities, epidemiological investigations, together with guidelines for dealing with diseased animals and contaminated premises and materials, have proved to be the critical links in the chain of actions needed to prevent, control and eradicate diseases. Disinfection, as an integral part of the protection of animal health, has become more sophisticated and more effective over this period. The historical trends suggest that disinfection will be even more important in the future, and that disinfectants and procedures must be further developed to keep pace with new scientific findings, changing agricultural structures and contemporary social concerns.


INTRODUCTION

The control of animal diseases and the prevention of new disease incursions is necessary to maintain the quality of life in a country. The threat of such diseases is ever present in all countries today. Animal industries are important to the health and wellbeing of the human population and to the economic viability of most countries. Preventing the entry and spread of disease agents is a critical component in maintaining animal health, and the effective use of disinfectants is a vital and necessary step in this overall process.

Historically, there are many instances when disinfectants have been used successfully in the control and prevention of both human and animal diseases. One can easily project an even more important role for disinfection in the future, in view of the significant increases in global trade in agricultural products. However, a new level of scrutiny should be expected, due to the potential consequences of the application of disinfectants, especially in the areas of human and environmental health.

This paper briefly describes developments in the use of disinfectants in animal health since the beginning of this century, and the changes which are most likely to occur in the future to modify the way disinfectants are viewed and used.

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RECENT HISTORY

As used in animal health and production, disinfectants were developed in a somewhat empirical manner. A number of substances were widely used as disinfectants before scientifically-valid tests were available to verify their efficacy. Many of the original disinfectants were probably inspired by personal hygiene practices, such as rinsing dishes in scalding water and placing bedding in the sunlight in the spring. The principle applied was probably: 'If it is good for the family, it should also be good for the animals.' Frequently, the same medicinal agents used to treat members of the family were also used on domestic animals.

Certain qualities became associated with the efficacy of disinfectants. The smell of pine tar is symbolic of a clean sanitary area. Many of the coal tar-derived phenolic compounds used as disinfectants smelled like pine tar. Even today, many household cleaning compounds, especially those designed for use in the bathroom, have a strong odour of pine tar. Likewise, a strong odour of pine tar appears often to be expected from livestock and poultry production facilities, trucks, stockyards and related equipment which have been recently disinfectected. Another organoleptic quality associated with a good disinfectant was the degree of irritation which the substance caused when applied to wounds or even intact skin. A widely-held opinion was that a good, strong disinfectant should be caustic, producing a burn or a tingling, stinging sensation. In some instances, materials used to help keep food from spoiling, such as wood ashes, lime and salt, were used as disinfectants.

Soon after the development of the technology required to isolate and replicate pathogenic microbes, sound scientific methods became available for testing the efficacy of disinfectants. Many naturally-occurring compounds - and even sunlight - were found to have antimicrobial properties. However, a number of other substances (e.g. chlorine, iodine and phenolic compounds) were (and still are) widely used as disinfectants. The effective virucidal concentration of many disinfectant formulations has been established over time through a variety of laboratory studies and field trials. Essentially, three core disinfectant formulations emerged, which have also been reliably and successfully used, especially for emergency situations. Sodium hypochlorite, sodium hydroxide and phenolic compounds are acknowledged as effective formulations in a variety of animal disease settings.

It soon became apparent that chemicals which would inactivate pathogens in an otherwise sterile environment, such as in a Petri dish, were not equally effective in the presence of large amounts of organic material, such as faeces, urine and blood. As soon as the active ingredient reacted with organic matter, the efficacy as a disinfectant was lost, often before the disinfectant had inactivated the target pathogens. When this knowledge was applied to common practices, it soon became widely recognized that any surface to be disinfected must first be thoroughly cleaned to remove all extraneous organic material.

The disinfection of premises, buildings, pens, enclosures, equipment, protective clothing and vehicles contaminated with manure, urine and other discharges from infected animals, is best accomplished in the following order:

- removal and decontamination of bulky materials by composting, burning, burying, or chemical treatment
- washing with water and detergent
- finally, application of an effective disinfectant.
In addition, it was learned that a certain amount of time may often be required after disinfection to permit the natural destruction of any surviving organisms. Only then might susceptible animals safely come into contact with previously-exposed premises or items.

As the science of disinfectants continued to develop, it was learned that chemicals which reduce surface tension (wetting agents) often enhance the efficacy of disinfectants. Other agents which form a thin film on drying increase the residual efficacy. It was also realized that the efficacy of disinfectants could be further enhanced by including several active ingredients and additives in the same formulation of concentrated disinfectant. The range of target organisms was broader, it was easier to dilute the concentrate with the correct amount of water, and the residual efficacy persisted much longer. In general, these multiple-ingredient products were easier to market and use; although some agents, such as chlorine, are still widely used as single-ingredient disinfectants.

While cleaning and disinfection procedures have become generally standardized for conventional husbandry practices, disinfection must also be used and customized for a variety of other settings, such as premises with slats and dirt floors, or for liquid-manure handling systems. Core formulations need to be altered, depending on the type of husbandry being considered. Disinfectants will also need to be customized to meet the changing structure of the farm-animal industries in some countries. Large, vertically-integrated production practices will put new pressure on effective disinfection procedures, as these intensive units are adopted to accrue financial savings from economies of scale in production systems.

**FORECAST**

The areas presenting the greatest future need for the application of disinfectants may be summarized as follows:

- vehicles and conveyances hauling animals
- animal production facilities
- animal processing facilities
- import and export facilities
- disease outbreak control situations.

While the immediate goal of a disinfection programme is to prevent the spread of disease, other factors and consequences must also be considered. The corrosive nature of the formulation and the potential environmental and human health impacts must also be assessed when making decisions on the use of disinfectants.

**PROBLEMS**

Few commercially-available disinfectants have been shown to be non-carcinogenic or non-teratogenic, while most disinfectants damage the environment at least to the extent that they often kill beneficial microbes as well as target organisms, and have the potential to contaminate ground water and air.
The development and safety testing of new disinfectants can be expensive.

Recent developments affecting the use of disinfectants include the following:

- transgenic animals and their potential for resistance or increased susceptibility to disease agents
- capital investment required for intensive animal production facilities which contain electric motors, electronic sensors and other devices that may be damaged or destroyed by corrosive disinfectants
- heightened concern over the presence of serious human pathogens and violative residues in products of animal origin (e.g. meat and eggs).

NEEDS

The following future needs can be identified in the field of disinfection:

a) disinfectants which damage only the targeted organisms
b) disinfectants which leave no harmful residue when used in animal production or human food-processing facilities
c) disinfectants which will not damage structural materials, especially those used in aircraft, ships, trucks and electronics
d) disinfectants which will not contaminate ground water or pollute air
e) disinfectants which are proven without doubt to be non-carcinogenic and non-teratogenic
f) application methodology to assure uniform wetting of surfaces to be disinfected without excessive use or wastage of chemicals which may affect the environment
g) application of principles of risk analysis in making decisions with regard to the need for application of disinfectants and the methods of application, to ensure (as far as possible) that no more disinfectants are used than are actually needed
h) alternative disinfectants, such as synthetic formulations, which are biodegradable, and harmless to humans and the environment (some of these synthetics are now on the market but lack extensive efficacy testing for specific pathogens).

DISCUSSION

Defences against pathogenic microorganisms may be impaired in some transgenic animals (animals with altered or deleted genes) and animals receiving additives or enhancers to increase production. The amount of increased care, therapy and disease prevention required will largely depend on the extent to which the defences of such animals have been impaired. Increased sanitation will be very important, and judicious use of disinfectants will become increasingly important to reduce diseases in this class of animals.

Facilities to produce and care for all classes of food-producing animals and those with impaired defences (including laboratory animals) are very expensive to build and operate. A wide range of electronic and mechanical devices are being used to reduce
costs and improve the environment for animals. All of these devices will need to be disinfected at some stage. Either the devices will have to be built to withstand disinfection with currently-available products, or less corrosive disinfectants will have to be developed.

Human pathogens of animal origin, such as certain *Escherichia coli*, *Salmonella* spp. and *Campylobacter* spp., are causing much concern. Methods need to be developed for the automatic disinfection of knives, instruments and mechanical devices after use on each carcass, to reduce transmission from carrier to non-carrier animals during slaughter and processing. Hot water and steam are satisfactory in some situations, but better disinfectants and improved methods of application are needed in some situations to control human pathogens of animal origin, without producing disinfectant residues in humans.

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**Résumé**

Les programmes de prévention, contrôle et éradication des maladies animales sont, à maints égards, étroitement liés. La preuve a été faite, au cours des cent dernières années, qu’en matière de santé animale la surveillance, le diagnostic, la rapidité de la réaction, les pouvoirs publics, les enquêtes épidémiologiques ainsi que les directives concernant les animaux malades et les locaux et équipements infectés constituent tous des maillons importants dans la chaîne des mesures à prendre pour prévenir, contrôler et éradiquer les maladies. La désinfection, qui fait partie intégrale de la protection de la santé animale, n’a cessé de se perfectionner et de gagner en efficacité tout au long de cette période et les tendances historiques montrent qu’elle est appelée à jouer un rôle encore plus important à l’avenir. Ces outils doivent donc être améliorés en fonction des dernières découvertes scientifiques, de l’évolution des structures agricoles et des préoccupations sociales contemporaines.

**MOTS-CLÉS** : Désinfection – Histoire – Perspectives – Santé animale.

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**Resumen**

Los programas de prevención, de control y de erradicación de las enfermedades animales están estrechamente relacionados, de distintos modos. Durante los últimos cien años se pudo comprobar que, en materia de sanidad animal, tanto la vigilancia, el diagnóstico, la velocidad de la reacción y las actitudes de los responsables de reglamentación, como las características de las encuestas epidemiológicas y de las directivas referidas a los animales enfermos y a los locales y equipos contaminados, son eslabones importantes en la cadena de las medidas que deben tomarse para prevenir, controlar y erradicar las enfermedades. La desinfección, en tanto que constituye un aspecto de la
protección de la sanidad animal, se ha ido perfeccionando y haciéndose cada vez más eficaz a lo largo de este período. La tendencia histórica observable indica que está llamada a desempeñar un papel aún más importante en el futuro, lo cual obliga a mejorar esta herramienta en función de los recientes descubrimientos científicos, de la evolución de las estructuras agrícolas y de las preocupaciones sociales contemporáneas.

PALABRAS CLAVE: Desinfección – Historia – Perspectivas – Sanidad animal.