SOME FACTORS INFLUENCING THE EFFECTIVE USE OF DISINFECTANTS AND CLEANING AGENTS

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OPSOMMING

Die doel van ontsmetting is om mikro-organismes te vernietig en sodoende verspreiding van infeksie te voorkom. Die ontsmettingsmiddel wat gebruik word, moet geskik wees vir die funksie wat dit moet verrig. Verskeie faktore, soos die tipe organisme wat teenwoordig is, konsentrasie van die oplossing, blootstellingstyd, temperatuur, pH en teenwoordigheid van organiese stowwe, moet in ag geneem word by die keuse en gebruik van ontsmettingsmiddels. Waar hierdie faktore verontagsaam word, kan die ontsmettingsprosedure nutteloos wees en selfs gevare inhou.

'n Lys van chemiese ontsmettingsmiddels wat algemeen gebruik word, word saam met hulle gebruike en voor- en nadele gegee.

DEFINITION

Disinfection means the freeing of an article from some or all of its burden of live pathogenic micro-organisms which might cause infection during its use. The term is a relative one and disinfection may be described as being partially or highly effective according to the proportion of pathogenic organisms killed or removed (2, p 59).

Disinfection needs to be used rather than sterilisation in many circumstances. It is, for example, unnecessary and impractical to sterilise bedpans, baths, eating utensils and so on. Pathogens which are possibly present on many fomites, are not spore forming and the vegetative forms will succumb sufficiently to disinfection to prevent the spread of infection.

Before discussing any methods of disinfection it must also be stressed that basic hygienic measures, carried out efficiently, will substantially reduce the number of organisms present in the patient's total environment. Therefore the simple procedures of washing, cleansing and ventilation should not be regarded as menial tasks to be undertaken only by the lowest ranking workers who are usually ignorant of the importance of their task and frequently do not have adequate equipment with which to perform it.

SELECTION OF DISINFECTANT

The disinfectant which is selected must be capable of performing the required task. Selection is dependent on the conditions in which the disinfectant must function, such as duration of exposure, temperature, pH and the presence or absence of neutralising agents. The purpose for which, and conditions under which, a disinfectant is to function will therefore determine the type of disinfectant to be used. Random selection of a bottle or prettily coloured fluid (which smells so clean!), followed by pouring a *dollop* into any available bowl is not by any means the correct approach, although probably the most commonly used method. One reason for this could be the inconvenience caused by careful measuring. This could be overcome by placing clean and correctly marked measures at all strategic points (kitchen, sluice, bathroom, dressing room, toilets). Other practical considerations are also important, as is illustrated by the spectacle of two nurses trying to lift and empty a large rubber bin containing 50 litres of fluid. Most nurses have not received sufficient physical training to prepare them for this task!

In this article important factors relating to the use of disinfectants are discussed. While most nurses will probably feel *they've heard it all before,* the fact remains that in the practical situation they fail to take account of those conditions which will determine the success or failure of their efforts.

Several studies have shown that by ignoring these factors contamination of a variety of articles which could then transmit infection to others, patients as well as staff, can occur. In a survey of fourteen hospitals Ayliff *et al*[1)] found that floor-cleaning mops were frequently contaminated by potentially pathogenic Gram-negative bacteria. Cleaning cloths, nail brushes and wash bowls, were equally contaminated, as were 19% of 213 thermometers surveyed. In all cases use had been made of disinfectants. Communal jars of handcreams and liquid soap were also frequently contaminated. This emphasises the point that disinfectants, to be effective, must be properly used and understood both at ward level and at administrative level where hospital policy is formulated. Ayliff's work also indicates the danger attached to the false sense of security created by the liberal use of disinfectants. They may be totally useless in the situation for which they are being used. There should be a carefully

devised protocol for the use of disinfectants in any hospital situation. Patterns of bacterial resistance should be known and a multi-disciplinary team should change the disinfection policy accordingly. Representatives of all groups who use disinfectants need to work together to establish principles which can be maintained by practical and easily observed measures.

SOME FACTORS RELEVANT TO THE USE OF DISINFECTANTS

Characteristics of micro-organisms

Nonspore-forming organisms. Some of these organisms are not as readily disposed of as others. The tubercle bacillus for example, is particularly resistant to destruction by chemical disinfectants while the gonococcus and meningococcus readily succumb to most methods of destruction.

While this article is mainly concerned with chemical methods of destruction it should be noted that the hepatitis virus (all forms) is not affected by boiling (100°C) for 30 minutes or longer. It is essential to use suitable chemicals or autoclaving when dealing with this organisim.

Spore-forming organisms. It is well known that spores need to be dealt with by sterilisation procedures such as autoclaving. Most chemicals are ineffective against these organisms although some chemicals such as glutaraldehyde, will destroy them.

Number of organisms. In the presence of many micro-organisms, such as in faeces or sputum, they tend to clump together and are further protected by the presence of organic material. In such cases the penetration of the disinfectant is impaired and the exposure time and/or the quantity of solution must be increased.

Species of organisms. a knowledge of the potential pathogens which may be present in a certain situation

TABLE 1
COMMON CHEMICAL DISINFECTANTS AND THEIR USES, ADVANTAGES AND DISADVANTAGES

Active principles	Uses, advantages and disadvantages
HALOGENS	
Chlorine gas	Disinfection of drinking water.
Calcium hypochlorite	Releases chlorine and is used on faeces or urine where the sewage system is inadequate. Allow to stand for one hour.[3]
Sodium hypochlorite	Used to disinfect drinking water. *Eusol* is used for wound irrigation. Effective against viruses but not against TB bacilli. Is inactivated by organic material, corrodes metal and damages cloth. Make up fresh solution in clean container daily.
Iodine	Is combined with alcohol for skin preparation. Inactivated by organic matter. Causes rapid destruction of vegetative forms of organisms and fungi but slowly sporicidal. Many individuals are sensitive to iodine.[2]
Iodophers (iodine plus anionic detergent)	Useful for surgical scrub.[3]
ALCOHOLS	
Ethyl alcohol	Weakly antiseptic — affects the physical structure of lipid membranes. No effect on spores and many viruses. Removes surface dirt and some bacteria prior to injections.
METALLIC COMPOUNDS	Formerly used in eyes of newborn. Some authorities still use it for major burns but there are many problems attached to its use, such as staining.[2]
PHENOLICS	
Phenol	Corrosive to animal tissue. Used as a standard for testing disinfectants. Derivatives are mainly coagulative in action, also has a toxic and dissolving action. Many compounds are surface tension reducers and remain absorbed as thin films on surfaces to which applied and therefore have a longer lasting action than alcohol or halogens.
Bisphenols Hexachlorophens	Retain action in the presence of soap and are often combined with surface tension reducers. Hexachlorophene is absorbed through skin, even if intact, and should not be used to bath babies or as a vaginal deodorant. Effective against Gram-positive and some Gram-negative organisms. Ineffective against pseudomonas. Controlled use will prevent staphylococcal infection in paediatric and maternity wards.[2),3)]
Cresols	Used to soak contaminated instruments and for general cleaning. Corrosive in high concentration. They have little action on viruses.[3]
Orthophenyl phenol	Similar to bisphenols.[3]
Pine oil	Is effective against many Gram-negative organisms including S. Typhi.[3]

Chloroxylenol	Weak antiseptic. Useful for Gram-positive organisms but not effective against Gram-negative. It even grows pseudomonas readily. Easily inactivated by organic material.[2),4)]
Chlorophenol	Similar to chloroxylenol. Damages tissues in high concentrations.[2)]
DIGUANIDES	
Chlorhexidine	Inactivated by soap and organic matter, and impaired by rubber, cotton, cork and plastic. It is valuable for staphylococci control but has no action on TB bacilli and viruses and little action on proteus and pseudomonas. Combined with 70% alcohol it is useful for skin cleaning as it has a fairly broad spectrum of action. Does not destroy spores, however, and should therefore not be used as a skin preparation in above knee amputations and bowel surgery.[4)]
Piclodoxine	General purpose antiseptic.
ALDEHYDES	
Gluteraldehyde	Is stable in acid solution but more active in alkaline medium. (Therefore some proprietry products have an alkaline buffer added). It is a powerful antiseptic which acts on spores and viruses and is stable for one week. It is used at 2% strength. Often used in intensive care units and is useful for cystoscopes, anaesthetic equipment, plastics, thermometers. It irritates the eyes, skin and mucus membranes but less so than formaldehyde.[2)]
Formaldehyde	Used for fumigation and sterilisation with steam and effectively destroys spores but irritates tissues. Very useful for articles damaged by heat, such as blankets, clothing, respirators and hairbrushes.
QUATERNARY AMMONIUM COMPOUNDS (Cationic) Cetyltrimethyl Ammonium bromide Benzylkoniumchloride	Action impaired by rubber, cotton, cork and plastic. Must never be mixed with soaps (anionics) because of incompatible charges of the ions. Therefore also less effective in hard water and water rich in iron. Used on skin and wounds where they act mainly on Gram-positive organisms. They have no action on TB bacilli, spores and fungi. Quaternary amonium compounds are useful because they are relatively inexpensive, only slightly injurious to tissues, effective against many organisms, stable and non-corrosive. They also dissolve easily in water, and do not have an inoffensive odour or stain. They must however be used properly otherwise they may support the growth of organisms.[(2,4)]
OXIDISING AGENTS	They are moderate disinfectants, but are easily inactivated by organic matter and therefore generally no longer recommended.[2)]
SOAP	Good anionic detergent and cleaning agent mainly because it is a powerful surface tension reducer and emulsifies fats and oils. Good for mechanical removal of bacteria.[2)]
DYES	Their effectiveness depends on concentration
Crystal Violet	Inhibits most Gram-positive organisms and is antifungal.

will result in the selection of a more appropriate disinfecting agent. Bedpans will probably be contaminated by Gram-negative organisms and using a substance such as Chloroxyanol for disinfection will be a waste of time — and even dangerous if it is then assumed that the bedpans are free from pathogens.

The disinfectant

Concentration of the disinfectant solution. Using an unnecessarily high concentration of disinfectant is not only wasteful but can cause damage to human tissue. Traumatised tissue will be most susceptible to further infection, particularly for those who are in daily contact with numerous organisms. If the concentration of disinfectant is too low it will be ineffective.

Time is closely related to the necessity for correct concentration. The important principle of *strong enough for long enough* must be upheld if adequate disinfection is to take place. About one hour of contact should generally be allowed. It must also be remembered that Gram-negative organisms take longer to destroy by chemical means than Gram-positive organisms.

Another important factor to bear in mind is that most disinfectants will be more effective in warm conditions than in cold conditions. Within the limits of the thermostability of the substance used one should therefore use hot water for making up the solution. This generally speeds up the chemical reaction and also lowers surface tension.

Surface tension. This is a vitally important aspect of disinfectants and those with a low surface tension are of great value. There are many substances such as household detergents which are used for cleaning purposes by virtue of the fact that they lower surface tension. Other substances, such as the quaternary ammonium compounds are both disinfectants and surface tension reducers. Unfortunately many of these substances are associated with foaming and the suds cause endless problems for hospital sanitarians. Sometimes a surface tension re-

TABLE 2
SOME COMMON OR TRADE NAMES OF PRODUCTS CONTAINING THE VARIOUS CHEMICALS

Active Principle	Example by Trade or Common Name
HALOGENS	
Calcium hypochlorite	Chloride of Lime
Sodium hypochlorite	Jik, Chloros, Milton, Eusol (differ in strength)
Iodine	Tincture of Iodine
Iodophers (iodine plus anionic detergent)	Betadine (povidone-iodine)
ALCOHOLS	
Ethyl alcohol	Surgical spirit
METALLIC COMPOUNDS	Silver nitrate
PHENOLICS	
Phenol	Carbolic acid
Bisphenols Hexachlorophene	Lysol, Phisohex
Cresols	Jeyes Fluid
Orthophenyl phenol	Osyl
Pine Oil	In proprietary household cleaners
Chloroxylanol	Dettol
Chlorophenol	Hycolin
DIGUANIDES	
Chlorhexidine	Hibitane
Piclodoxine	Diglutonate, Resiguard
ALDEHYDES	
Gluteraldehyde	Cidex
Formaldehyde	Formalin, Gas
QUARTERNARY AMMONIUM COMPOUNDS (Cationic)	
Cetyltrimethyl Amonium bromide	Cetavlon Cetrimide
Benzylkoniumchloride	Ziphiren
OXIDISING AGENTS	Potassium Permanganate, Hydrogen peroxide
DYES	
Crytal Violet	Gentian violet
Other	Acriflavine

ducer is added to a disinfectant in order to increase its efficiency.

Organic material. As has been mentioned the presence of organic material may inhibit or interfere with the action of a disinfectant. Some substances will coagulate the organic material and form a protective coating for the organisms. Many chemicals combine as readily with matter such as blood or mucus as with the vital cell complexes of the micro-organisms. This could reduce the amount of disinfectant available to act on the organisms. If elimination by thorough washing of an item is not possible, solid masses, such as faeces, must therefore be broken up and the quantity of disinfectant increased to cope with blood or mucus.

Obviously, complete contact between items and the disinfectant is required. Air bubbles must be eliminated and objects completely submerged in the disinfectant solution. Oil or grease may also need to be cleaned off initially.

Deterioration of solution. Solutions deteriorate and as a general rule they should be replaced daily. They should never be *topped up*.

Exposure to other inhibiting factors. Nurses should always be aware of factors which impair disinfectant action (see table 1). For example, cotton wool swabs should not be applied directly to the top of a bottle of any quaternary ammonium compound — by the time the bottle is half used the substance will be ineffective.

DISINFECTION METHODS

Heat

Washing in water at 65°C - 80°C for 10 minutes, such as laundering contaminated sheets and washing eating utensils will render articles safe for re-use under general circumstances. Disinfection through heat is also achieved by pasteurisation of certain items such as tubing, or boiling, for example glass syringes, at 100°C for 10 minutes. This method is ineffective for the hepatitis virus.

Chemical disinfectants

In table 1 common chemical disinfectants are discussed in terms of their uses, advantages and disadvantages. Table 2 provides common or trade names of products containing the various compounds.

Antiseptics

Antiseptics are the *weaker* or non-toxic disinfectants. These are usually used on the skin and must therefore be non-irritating and should act against Gram-positive

organisms in particular. Transient organisms are relatively easily destroyed but some, such as staphylococcus aureus growing in the depths of the skin, are more difficult to remove. Hexachlorophene 3% is effective against staphylococci and streptococci and chlorhexidine with 70% alcohol is broad spectrum, although it does not destroy spores.

Surface disinfectants

Surface disinfectants are used between cases on operating tables and on dressing trolleys, floors, walls, baths, etc. Pathogenic streptococci, staphylococci, enterobacteria and pseudomonas are all often found in hospitals — on the floors, furniture, in kitchens, bathrooms and toilets. The disinfectants used for surfaces should be quick-acting and broad spectrum. Their use should be preceded by adequate mechanical cleaning to eliminate obvious organic matter.

Hypochlorites may be used as they do not leave a toxic residue. Baths and washbasins should be cleaned regularly with a cleaning powder containing hypochlorites and in toilets the seats, flushes and doorhandles should be wiped with a hypochlorite solution. This applies equally to working-surfaces in kitchens. Chlorhexidine with 70% alcohol could also be used for trolleys.

General disinfectants

It is often necessary to decontaminate articles before re-use or disposal. General disinfectants have a wide range of use and should therefore have a broad spectrum of activity, even if not quick-acting. Wherever possible they should undergo in-use testing in order to ensure their effectivity under the conditions in which they are actually used.

Phenolics are frequently used as they partly withstand inactivation by organic material. They do, however, irritate the skin.

CONCLUSION

For many people, in hospitals, creches and in other situations, the problem of preventing the spread of infection is immense. There is a vast array of chemicals on the market to assist in this task. However, these chemical disinfectants are frequently not well understood or used correctly and can thus cause more harm than good. Consequently, all who use disinfectants need an awareness of the basic principles to be maintained as well as some understanding of the nature of micro-organisms to be controlled. It is only with a knowledge of the structure, function, and response of organisms that this *enemy* will be defeated.

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COMPLETED RESEARCH VOLTOOIDE NAVORSING

'N ONDERSOEK NA DIE DAARSTELLING VAN 'N SENSORIES-MOTORIESE STIMULASIE- EN LEERPROGRAM VIR GEESTESVERTRAAGDE VOORSKOOLSE KINDERS OF RISIKOGEVALLE IN DIE GEMEENSKAP DEUR VERPLEEGKUNDIGES IN DIE PSIGIATRIE

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Met hierdie ondersoek is gepoog om sensories-motoriese stimulasie- en leerprogramme vir geestesvertraagde voorskoolse kinders in die gemeenskap daar te stel.

Die ondersoek is onderneem om vas te stel of

(1) 'n werkstruktuur waarbinne die verpleegkundige so 'n program van stapel stuur, geskep kan word; en

(2) of die stimulasie- en leerprogram 'n bydrae tot die ontwikkeling van geestesvertraagde kinders lewer.

'n Beskrywende studie is gedoen. Die tegnieke wat gebruik is om die verloop van die ondersoek te illustreer, was deelnemende waarneming en die gevallestudie.

Drie gevallestudies is gebruik om die vordering van die kinders, die rol van die ouers en die verpleegkundige en die probleme wat ondervind is, te illustreer.

'n Werkstruktuur waarbinne so 'n program van stapel gestuur kan word, is geskep. Daar is gevind dat indien 'n geestesvertraagde kind aktief by 'n stimulasie- en leerprogram betrek word, agteruitgang voorkom word en geringe, maar waardevolle verbetering bewerkstellig word.

Opsporing van geestesvertraagde kinders moet egter vroeër gedoen word.

So 'n program word deur die navorser beskou as 'n belangrike deel van die geestesgesondheidsdiens in enige gemeenskap.