Safety Services Guidance

Guidance on Laboratory Chemical Disinfectants – Selection and Use

Key word(s):	Disinfectants, formaldehyde, gluteraldehyde, QAC (quaternary ammonium compounds), hypochlorites, alcohols, peroxide compounds
Target audience:	Workers in biological and GM laboratories

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Introduction

1. Chemical disinfectants reduce the number of micro-organisms to a level below which infectivity is destroyed and the disinfected object rendered safe to handle. Disinfection is not an alternative to sterilisation, but chemical disinfection may, where appropriate, be followed by autoclave treatment or by incineration.

2. When planning a procedure a risk assessment must be carried out. The risk assessment should specify the disinfectant to be used and include the controls and personal safety measures, including personal protective equipment, to be employed when handling concentrated and working dilutions. It should specify any materials used in the protective equipment to ensure they are compatible with the chemical disinfectant selected.

3. The manufacturer's information and Safety Data Sheet (SDS) should provide most of the relevant information needed to help choose the most suitable disinfectant and complete a risk assessment. In some cases, in-house test data of efficacy may need to be undertaken.

4. In addition to the risk assessment, there should be a clear, documented disinfection protocol indicating suitable concentrations, contact times, applications and replacement frequency for all disinfectants in use. This should be incorporated into local arrangements and also displayed in all areas where disinfectants are being used. It is important that all workers understand which disinfectant to use, how to use it and why it is the disinfectant of choice. If the disinfectant chemical is changed, a new risk assessment will be needed. Changes should be discussed with your local biological safety advisor.

5. The number of different disinfectants used in a laboratory should be kept to a minimum to avoid mistakes in application and reduce the number of risk assessments. See Appendix 1 for details of the different types of disinfectant.

6. The EU Biocides Regulation (528/2012) regulates which disinfectants are authorised for supply and for which purposes.
   See http://www.hse.gov.uk/biocides/basics.htm for more information.

Choosing an appropriate disinfectant

7. You need to consider:

- Is it really necessary?

Consider whether the disinfectant stage is necessary, especially if waste treatment by autoclaving or incineration is likely.

- The micro-organisms to be destroyed

The spectrum of activity of disinfectants varies considerably. For example, a disinfectant which is effective against bacteria may not be as effective against viruses and disinfectants do not normally kill bacterial spores. It is important to check the manufacturer's data regarding the specific antimicrobial activity of their particular products.
If the types of micro-organisms in samples or materials handled are unknown, then a general purpose, wide spectrum disinfectant should be chosen.

- Whether the disinfectant is going to be used in a clean or dirty situation

The presence of other materials in liquid wastes or on the surfaces to be disinfected can reduce the activity of the disinfectant. Organic material (e.g. proteins, foetal calf serum, biofilms), chemical agents such as soaps and detergents and the pH and temperature can all reduce the effectiveness of the disinfectant.
The concentration of disinfectant needed will vary depending on whether it is used in "clean" or "dirty" conditions and whether it is used routinely or in the event of an accident. If disinfectants are left to stand, their effectiveness will decrease over time.

- The nature of the surfaces and equipment to be disinfected

The contact time between the disinfectant and the material to be decontaminated can be critical. For example, air bubbles on submerged articles will prevent total contact with the surface area; intracellular viruses can be more resistant to disinfectants than free viruses.
Some disinfectants are not compatible with certain substances and will chemically attack the items being disinfected. For example, stainless steel can be damaged by strong acid, plastics are attacked by organic solvents, metals may be affected by strong acids or alkalis, halogen active substances or disinfectants containing electrolytes.

- Validation

The effectiveness of disinfectants must be validated to determine the optimal combination of concentration and contact time needed to ensure that the procedures used to reduce viability are effective for the infectious agent to be controlled under the conditions of use. The manufacturer's data can be used provided the conditions of use in the laboratory can be equated to the

manufacturer's methodology. The reliance on such data needs to be proportional to the risk and where necessary, in-house validation may be needed to supplement the data.
Remember to re-validate when changes in working practices, new micro-organisms or new materials are proposed.

- Health effects

Most disinfectants have toxic properties and some are very corrosive, causing damage if they come into contact with skin or eyes. Others are irritants, causing respiratory problems if used in poorly ventilated areas. Some disinfectants may react with other chemicals causing hazardous gases.

Handling and Use

8. Some types of disinfectants release vapours that are sensitising or irritant and should be used only in well ventilated areas. Others release hazardous gases when mixed with other chemicals.

9. Keeping the number of disinfectants in use to a minimum will avoid errors and ambiguities in use and accidental mixing of compounds to give rise to hazardous reactions or the formation of toxic products.

10. Splashing should be avoided, and appropriate personal protective equipment worn e.g. gloves and face protection, as specified in the risk assessment.

Spillages involving Biological Agents

11. Procedures for dealing with spillages should be part of the risk assessment and take into account the organisms involved and the size of spill. There should be a clear plan of action for dealing with spillages and disposing of the material safely, and an evacuation plan for significant spills.

12. Effective disinfectants should be available for immediate use in the event of spillage. Disinfectants supplied in powder or granular form (e.g. Virkon and Presept) are especially useful for sprinkling over spills to contain them. Liquid disinfectant used on a spill may increase the surface area and spread it further and may also result in splashing but if there is no alternative, then splashing can be minimised by covering the spill with tissue or paper towels before pouring on the liquid disinfectant. Bench tops and laboratory equipment must be cleaned or disinfected immediately after use or on a regular basis and should be thoroughly decontaminated before removal, repair or servicing.

Spill Kits

13. These can be bought or made up in-house. They should be readily available and adequate for purpose.

Making Up Working Dilutions

14. Disinfectants are usually supplied in a concentrated form that needs to be diluted to the correct working strength for immediate use. Some, however, are meant to be used undiluted. Over-dilution will render the disinfectant ineffective. Once made up, the disinfecting capacity of diluted products tends to deteriorate rapidly with time so the effective “shelf life” of diluted disinfectants should be included in the disinfection protocol.

15. Some products e.g. Virkon contain coloured indicators to show effective disinfecting capacity. If the disinfectant in use does not contain an indicator then the container should be clearly marked with a "use by" or expiry date when the solution is first made up.

Contact Times

16. Chemical disinfectants need to be applied to the item they are disinfecting for sufficient time to enable the process to be effective. Objects should be fully immersed and air pockets should not be present.

Wet Discard Jars

17. Items placed in discard jars must be completely submerged in the disinfectant and remain in the disinfectant for the appropriate length of time. Levels should be sufficient to allow for fluid displacement when items are added. If liquid waste is added to the disinfectant in the jar then the initial concentration needs to be proportionately increased to ensure the final concentration doesn’t drop below the effective disinfection concentration. The disinfectant can then be drained off and washed down a sink (not a hand wash basin) and the items sent for further treatment if necessary. If liquid waste is aspirated into a container then the amount of concentrated disinfectant added should allow for dilution to the final volume of the full receptacle.

18. Discard jars must not be allowed to become reservoirs of infection. They should be washed thoroughly and if possible, heat-treated before refilling.

University staff/students working on other premises

19. Staff and students may be required to comply with the requirements of a host institution. For example, those working in NHS Trusts may find that Trust policy requires the use of disinfectants which may be unfamiliar. If this is the case, it is essential that clear and unambiguous instructions for use, in accordance with local practices, are drawn up and followed. Line managers are responsible for ensuring that their workers are familiar with current working arrangements.

Skin disinfection

20. There should be no need for workers in laboratories to routinely disinfect their hands. Skin disinfectants are for use in clinical settings. All workers should wash their hands regularly whilst working in the laboratory, and always before leaving. Standard hand wash products are suitable for this and there is no need to use specialist antimicrobial products. If liquid soaps are used in containment laboratories they should contain a bacteriostatic agent to prevent the multiplication of any contamination. Cloth towels should not be used in laboratories. Single use paper towels are recommended.

Appendix: Types of Disinfectant, their properties and uses

The following types of disinfectants are commonly used in laboratories. Key points to be taken into account when selecting the disinfectant are given. Manufacturers' instructions should be consulted for suitable concentration and contact times and further details of applications.

Hypochlorites

Examples: Sodium hypochlorite, Presept, Chloros

- Available as solutions of sodium hypochlorite or powdered or tableted sodium dichloroisocyanurate (NaDCC). Do not use household bleaches.
- Wide range of bactericidal, virucidal, and fungicidal activity
- Limited activity against bacterial spores
- Rapid action
- Inactivated by organic matter, particularly if used in low concentration
- Corrosive to some metals and may damage rubber
- Compatible with anionic and non-ionic detergents
- Incompatible with cationic detergents
- Irritant
- Chlorine gas released when mixed with strong acids
- Carcinogenic products produced when mixed with formaldehyde
- One of disinfectants of choice for use against HIV and hepatitis B viruses
- Not very effective against Mycobacterium spp.

Peroxygen compounds

Example: Virkon

- Wide range of bactericidal, virucidal and fungicidal activity
- Variable activity against bacterial spores and Mycobacteria spp.
- Corrosivity varies with different products, but not recommended for metal surfaces
- Made up dilutions from tablets are better since powders are respiratory irritants. Solutions have low toxicity and no irritancy
- Built-in colour indicator
- Good detergent properties combines cleaning with disinfection
- Stable for approximately seven days on dilution, depending on use.

- Impaired by the presence of organic matter
- Vapourised hydrogen peroxide (VHP) can be used to fumigate microbiological safety cabinets and rooms

Quaternary Ammonium Compounds

Examples: Anistel, Distel (formerly Trigene) – mixture of QAC and halogenated amines

- Certified as having broad spectrum disinfectant properties i.e. bacteriocidal, fungicidal, virucidal, mycobactericidal, sporicidal
- Inactivates and breaks down DNA/RNA
- Compatible with a variety of surfaces including metals, plastic, glass and rubber
- No hazardous properties

Alcohols

Examples: Ethanol, Isopropanol, Methanol, Industrial Methylated Spirits (IMS)

- Good bacterial and fungicidal activity including Mycobacteria
- No activity against spores
- Variable activity against viruses (ethanol less effective against non- enveloped viruses, propanol not effective against viruses)
- Non-corrosive. Only recommended for limited use (such as on clean surfaces and for flaming forceps etc.) - seek alternative wherever possible
- Should only be used on physically clean surfaces as poor penetration of organic matter
- Rapid action
- Alcohols must be diluted to 70-80% before use (100% alcohol is not an effective disinfectant)
- Highly flammable

Formaldehyde

Formaldehyde has irritant and toxic properties and is extremely hazardous (WEL 2ppm) and should NOT be used as a general disinfectant in the laboratory. It may be employed only for specialised uses i.e. gaseous fumigation for disinfection of microbiological safety cabinets and laboratories.

N.B. Glutaraldehyde is a potent respiratory sensitiser (WEL 0.05ppm) and must NOT be used as a disinfectant.

Table 1 - Activities of some Common Classes of Disinfectants

Active against Disinfectant type	Vegetative bacteria	Bacterial spores	Fungi	Enveloped viruses	Non-enveloped viruses	Myco-bacteria	TSE and prion agents
Hypochlorites Chloros Presept	+	+	1	+	+	1	1
Alcohols 70% Ethanol 70% IPA	+	-	-	+	+	+	-
Aldehydes Formaldehyde	+	+	+	+	+	+	-
Peroxygen compounds Virkon	+	+	+	+	+	+	-

+ Generally effective
- Generally ineffective
1. Limited activity
2. Depends on the virus

Table 2 - Characteristics of some Common Classes of Disinfectants

Inactivated by Disinfectant type	Hazard Class	Organic matter	Hard water	Detergent	Corrosive to metals	Flammable
Hypochlorites	Toxic Corrosive	+	-	1	+	-
Alcohols	Harmful Flammable	-	-	-	-	+
Aldehydes	Very Toxic Irritant	-	-	-	-	-
Peroxygen compounds	Irritant (dust)	-	-	-	3	-

1 Inactivated by cationic detergents - can alter effectiveness
3 Inactivated by anionic detergents - no alteration in effectiveness

Other disinfectants

Many proprietary disinfectant products are available and new products are constantly being developed. The ones described above are suitable for general use in the laboratory for disinfecting surfaces and equipment etc. Manufacturers should clearly specify the types of applications their product is useful for. Users should be aware that certain disinfectants are specific inactivators of particular pathogens (e.g. Mycobacteria spp) and should be used in a manner which reflects the efficacy test conditions for that product. Products sold as skin disinfectants e.g. Hibiscrub, Hibitane, Betadine, pHiso-med, Cidal etc should not be used as a general laboratory disinfectant nor should products such as bleach or other household or domestic cleaning type disinfectants.

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