Guidelines on sterilization and high level disinfection methods effective against human immunodeficiency virus (HIV)

Introduction

The human immunodeficiency virus (HIV) can be transmitted from one person to onother through the use of non-sterile needles, syringes, and other skin-piercing and invasive instruments. Proper sterilization of all such instruments is therefore important to prevent its transmission. HIV is very sensitive to standard methods of sterilization and high- level disinfection, and methods designed to inactivate other viruses (e.g. hepotitis B virus) will also inactivate HIV.

Heat is the most effective method for inactivating HIV: methods for sterilization[a] and high-level disinfection[b] based on heat are therefore the methods of choice. High-level disinfection by boiling is feasible in most circumstances, as this requires only a source of heat, a container, and water. In practical and field settings, high-level disinfection with chemicals is far less reliable.

HIV transmission

HIV has been found in various body fluids from persons infected with the virus. However, only blood, semen, and vaginal and cervical secretions have been implicated in HIV transmission. Nevertheless, as all body fluids (including pus and other infected discharges and infected body cavity fluids, such as pleural fluid and crebrospinal fluid) may contain blood or white blood cells, it is essential that all medical instruments for invasive procedures (including needles and syringes) should be cleaned, then sterilized or given high-level disinfection for each separate patient to prevent transmission of HIV.

a *Sterilization is defined as inactivation of all microbes, including spores.*

b *High-level disinfection is defined as inactivation of all microbes except spores.*

Methods for sterilization and disinfection

It is imperative that all instruments be cleaned thoroughly before being sterilized or disinfected at high level by any method. It is suggested, particularly in health care settings where the prevalence of HIV infection among patients is high, that medical instruments should be soaked for 30 minutes in a chemical disinfectant before cleaning. This will give further protection to the personnel from exposure to HIV during the process of cleaning.

Sterilization by steam

Steam sterilization (autoclaving) is the method of choice for reusable medical instruments including needles and syringes. An inexpensive type of autoclave is an appropriately modified pressure cooker (WHO/UNICEF type). Autoclaves and pressure cookers should be operated at 121°C equivalent to a pressure of 1 atmosphere (101 kPa, 15 lb/in²) above atmospheric pressure, for a minimum of 20 minutes.

WHO and UNICEF have collaborated in developing a portable steam sterilizer containing an insert (rack), where needles, syringes and other instruments commonly used in health care settings can be fitted.

Sterilization by dry heat

Sterilization by dry heat in an electric oven is an appropriate method for instruments that can withstand a temperature of 70 °c (340 °F). This method is therefore not suitable for reusable plastic syringes. An ordinary electric household oven is satisfactory for dry heat sterilisation. The sterilization time is two hours at 170 °C (340°F).

High-level disinfection by boiling

A high level of disinfection is achieved when instruments, needles, and syringes are boiled for 20 minutes. This is the simplest and most reliable method for inactivating most pathogenic microbes, including HIV, when sterilization equipment is not available. Hepotitis B virus is inactivated after a few minutes of boiling and it is probable that HIV, which is very sensitive to heat, is also inactivated after several minutes of boiling. However, in order to be sure, boiling should be continued for 20 minutes.

High-level disinfection by soaking in chemical

Many disinfectants recommended for use in health care facilities have been found to inactivate HIV in laboratory testing. However, in practice, chemical disinfectants are not reliable, because they may be inactivated by blood or other organic matter present. Furthermore, they must be prepared carefully. They may also rapidly lose their strength, especially when stored in a warm place. Chemical disnfection must not be used for needles and syringes. Chemical disinfection for other skin-cutting and invasive instruments should only be employed as the last resort, if neither sterilization nor high-level disinfection by heat is possible and then only if the appropriate concentration and activity of the chemical can be ensured and if the instruments have been thoroughly cleaned prior to soaking in the chemical disinfectant.

The following chemical disinfectants have been shown to be effective in inactivating HIV:

sodium hypochlorite, 0.1 - 0.5% available chlorine;
chloramine 2% (tosylchloramide sodium);
ethanol 70%;
2-propanol (isopropyl alcohol) 70%;
polyvidone iodine 2.5%;
formaldehyde 4%;
glutaral (glutaraldehyde) 2%;
hydrogen peroxide 6%.

Other commonly used disinfectants may also be effective, but laboratory data on their effectiveness are not abailable.

Disinfection by wiping with a chemical

Wiping with an appropriate disinfectant is acceptable for surfaces such as table tops and for spilt blood. For visible spilt blood, the area should first be flooded with the disinfectant; the mixed blood and disinfectant should then be removed; finally the surface should be wiped with the disinfectant. Sodium hypochlorite is the preferred disinfectant. If alcohol is used, the surfoce should be wiped several times because alcohol eaporates rapidly.

High-level disinfectants

Chlorine-releasing compounds

(a) Sodium hypochlorite

Sodium hypochlorite solutions (liquid bleach, eau de Javel, etc.) are excellent disinfectants: they are bactericidal, virucidal, inexpensive and widely available.

However, they have two important disadvantages.

•**They are corrosive.** They will corrode nickel and chromium steel, iron, and other oxidizable metals.

Solutions exceeding 0.1% availabe chlorine should not be used repeatedly for the disinfection of good quality stainless steel equipment. Contact should not exceed 30 minutes and should be followed by thorough rinsing and drying.

Dilutions should not be prepared in metallic containers as they may corrode rapidly.

•**They deteriorate.** Solutions should be recently manufactured and protected in storage from heat and light.

Dilutions should be prepored just before use.

Rapid decomposition may be a major problem in countries with a warm climate.

Two other chlorine-releasing compounds (calcium hypochlorite, sodium dichloroisocyanurate) may be more suitable because they are more stable. In addition, they can be transported more easily and more cheaply. Their effectiveness, however, has not yet been evaluated.

(b) Calcium hypochlorite

a (powder, granules or tablets)

This substance also decomposes gradually if not protected from heat and light but it decomposes more slowly than sodium hypochlorite solution. It is available in two forms: "high-tested" calcium hypochlorite and chlorinated lime or bleaching powder.

Note: A deposit in solutions is normal.

a Calcium hypochlorite and sodium dichloroisocyanurate (NaDCC) solutions can be expected to inactivate HIV because they both generate hypochlorous acid in solution, and are therefore expected to act in a similar way to sodium hypochlorite.

(c) Sodium Dichloroisocyanurate

a (NaDCC)

When dissolve in water, NaDCC forms hypochlorite (hypochlorous acid); it is much more stable than sodium hypochlorite solution or calcium hypochlorite, and is generally formulated as tablets.

(d) Chloramine

(tosylchloramide sodium; chloramine T)

Chloramine is more stable than sodium hypochlorite and calcium hypochlorite. It should, however, be sored protected from humidity, light, and excessive heat. It is available as powder or tablets.

The disinfectant power of all chlorine-releasing compounds is expressed as "available chlorine" (% for solid compounds; % or parts per million (ppm) for solutions) according to the concentration level. Thus,

0.0001% = 1 mg/litre = 1 ppm ond 1% = 10g/litre = 10 000ppm

In some countries the concentration of sodium hypochlorite solution is expressed in chlorometric degrees (° chlorom.); is approximately equivalent to 0.3% available chlorine.

Household liquid bleach generally contains 5% available chlorine. Eau de Javel (15° chlorom.) contains Eau de Javel (1° chlorom.) contains approximately 5% available chlorine.
Extrait de Javel (48° chlorom.) contains approximately 15% available chlorine.
Calcium hypochlorite contains approximately 70% available chlorine.
Chlorinated lime contains approximately 35% available chlorine.
NaDCC contains approximately 60% available chlorine.
Chloramine contains approximately 25% available chlorine.

The amount of available chlorine required in solutions for high-level disinfection depends on the amount of organic matter present, since chlorine is inactivated by organic matter such as blood and pus.

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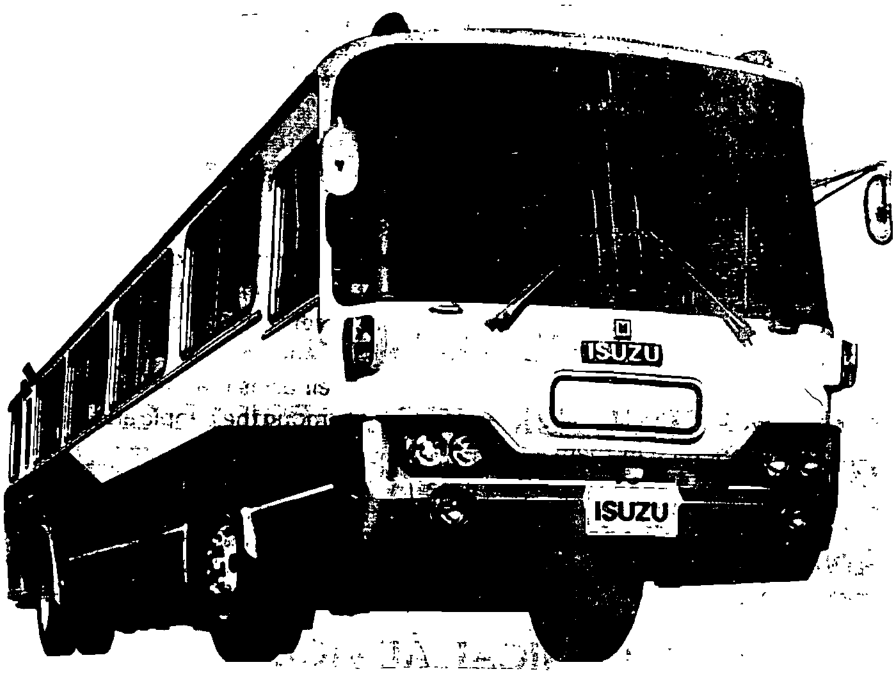
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Recommended Dilutions of Chlorine-releasing compounds

	Clean condition (e.g., cleaned medical equipment)	Dirty condition (e.g., blood spills, soiled equipment)
Available chlorine required	0.1% (1g/litre, 1000ppm)	0.5% (5g/litre, 5000ppm)
Dilution		
Sodium hypochlorite solution (5% available chlorine)	20 ml/litre	100 ml/litre
Calcium hypochlorite (70% available chlorine)	1.4 g/litre	7.0 g/litre
NaDCC (60% available chlorine)	1.7 g/litre	8.5 g/litre
NaDCC-based tablets(1.5g of available chlorine per tablet)	1 table/line	4 tablets/litre
Chloramine (25% available chlorine)	20 g/litre	20 g/litre

[a]*Chloramine releases chlorine at a slower rate than do hypochlorites. Therefore, a higher available chlorine concentration is required in chloramine solutions for the same effectiveness. On the other hand, chloramine solutions are not inactivated by biological materials (e.g., protein and blood) to the same extent as hypochlorites. Therefore, a concentration of 20 g/litre (0.5% available chlorine) is recommended for both clean and dirty conditions.*

Ethanol and 2-propanol

Ethanol (ethyl alcohol) and 2-propanol (isopropyl alcohol) have similar disinfectant properties. They are germicidal for vegetative forms of bacteria, mycobacteria, fungi, and viruses after a few minutes of contact. They are not effective against bacterial spores.

For highest effictiveness they should be used in a concentration of approximately 70% (70% alcohol, 30% water); lower and higher concentrations are less effective. Ethanol can be used in its denatured forms, which may be less expensive.

All alcohols are very expensive if they have to be imported, as they are subject to strict air-freight regulations requiring special heavy packaging. Importation of alcohol is forbidden in some Muslim countries.

Polyvidone Iodine (PVI)

Polyvidone iodine (PVI) is an iodophore (a compound that carries iodine) and can be used in aqueous solution as a potent disinfectant. Its disinfectant activity is very similar to that of hypochlorite solutions, but it is more stable and less corrosive to metals. It should not, however, be used on aluminium and copper.

It is commonly formulated as a 10% solution (1% iodine). It can be used *diluted to 2.5% PVI(1part 10% solution to 3 parts* boiled water).

Immersion for 15 minutes in a 2.5% solution provides high- level disinfection for clean equipment.

Dilute solutions (2.5%) for soaking instruments should be prepared fresh every day.

Formaldehyde Solution

The commercial formulations of formaldehyde (formol, formalin) generally contain 35-40% formaldehyde, 10% methanol, and water.

They should be used diluted 1:10 (the final solution containing 3.5-4% formaldehyde). This dilute solution destroys vegetative bacteria, fungi, and viruses in less than 30 minutes and bacterial spores after several hours.

After immersion, all equipment should be thoroughly rinsed before being reused. The solution and the vapour released are toxic and very irritant, and this limits the use of formaldehyde for disinfection.

Glutaral (Glutaraldehyde)

Glutaral (glutaraldehyde) is usually available as a 2% aqueous solution which needs to be "activated" before use. Activation involves addition of a powder or a liquid supplied with the solution; this renders the solution alkaline.

Immersion in the activated solution destroys vegetative bocteria, fungi, and viruses in less than 30 minutes. Ten hours are required for the destruction of spores.

After immersion, all equipment should be thoroughly rinsed to remove any toxic glutaral residue.

Once activated, the solution should not be kept more than two weeks. It should be discarded if it becomes turbid.

Stabilized glutaral solutions that do not require to be activated have been formulated recently. However, insufficient dota exist for their use to be recommended.

Glutaral solutions are expensive.

Hydrogen Peroxide

Hydrogen peroxide is a potent disinfectant whose activirty is due to the release of oxygen.

Immersion of clean equipment in a 6% solution provides high-level disinfection in less than 30 minutes.

The 6% solution should be prepared immediately before use from the 30% stabilized solution (1 part of stabilized 30% solution added to 4 parts of boiled water).

The concentrated stabilized 30% solution should be handled and transported with care because it is corrosive. It should be stored in a cool place protected from light. Hydrogen peroxide is not suitable for use in a hot environment.

Because it is corrosive, hydrogen peroxide should not be used on copper, aluminium, zinc, or brass.

Field guide to sterilisation and High level Disinfection: Techniques effective against HIV
After thorough cleaning, instruments should be sterilized by heat (steam or dry heat). If sterilization is not possible, hi;gh-level disinfection by boiling is acceptable. Chemical disinfection must not be used for needles and syringes. Chemical disinfection for other skin-cutting and invasive instruments should only be employed as the last resort, and only if the appropriate concentration and activity of the chemical can be ensured and if the instruments have been thoroughly cleaned prior to soaking in the chemical disinfectant.

Sterilization:
inactivates(kills) all viruses, bacteria and spores
Steam sterilizotion under pressure
In autoclave or WHO/UNICEF steam steriliser
for at least 20 minutes:
1 atmosphere (101kPa, 15 lb/in²) above
atmospheric pressure, 121 °C (25° F)

Dry heat sterilization:
2 hours at 170° C (340° F) In electric oven.

High-level disinfection: inactivates (kills) all viruses and bacteria; but not spores

Boiling for 20 minutes	In appropriate container
Immersion in high-level disinfectant for 30 minutes	e.g., sodium hypochlorite 0.5% available chlorine chloramine 2% ethanol 70% 2-propanol 70% polyvidone iodine 2.5% formaldehyde 4% glutaral(glutaraldehyde)2% hydrogen peroxide 6%

In practical and field settings, high-level disinfection with chemicals is far less reliable than boiling.

The great majority of us are required to live a life of constant duplicity. Your health is bound to be affected if, day after day, you say the opposite of what you feel, if you grovel before what you dislike and rejoice at what brings you nothing but misfortune

- Boris Pasternak

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