Use of disinfectants in the health care sector: Chemical hazards and preventive measures

Factsheet 8: Specific procedures (disinfecting premises, medical equipment, linen and clothing)

Foreword

The Chemical Risks workgroup of the Health Services Section of the International Social Security Association (ISSA) has studied the risks linked to disinfection activities in the health care sector and the preventive measures that should be applied. This workgroup has defined a position shared by all the occupational health and safety organisations represented within the group: BGW (Germany), INRS (France) and Suva (Switzerland).

This project included a collaboration with the Infectious Risks workgroup of the Section, to summarise the general principles of disinfection (Factsheet 1) for the audience targeted by the current series (see below).

For practical reasons, the results of this work will be presented as a series of technical Factsheets:

- Factsheet 1: Principles of disinfection
- Factsheet 2: General principles of prevention
- Factsheet 3: Hazards of chemical disinfectants
- Factsheet 4: Selecting safe disinfectants
- Factsheet 5: Surface disinfection
- Factsheet 6: Instrument disinfection
- Factsheet 7: Skin and hand disinfection
- Factsheet 8: Specific procedures (disinfecting premises, medical equipment, linen and clothing)

Each factsheet contains the essential information relating to the theme covered, and can therefore be read separately. These factsheets are destined for use by those responsible for organising and performing disinfection tasks in the health care sector, by occupational physicians and by all those involved in preventing occupational risks – in particular occupational hygienists and safety officers – as well as interested personnel and their representatives.

For questions on hospital hygiene and environmental protection, the reader is invited to consult the specialised literature.

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Section on Prevention of Occupational Risks in Health Services

1. Disinfection procedures

The disinfection procedures used in the health care sector other than those used to disinfect surfaces, instruments, hands and skin are dealt with here because of the dangers they represent and their frequent use. In particular, this covers procedures for:

- Disinfection of premises (e.g. using formaldehyde)
- Disinfection of medical equipment such as dialysis equipment
- Disinfection of linen and clothing

Examples will be given below and we will indicate, in particular, the main products and procedures used, and the measures applicable to prevent occupational risks, based on current exposure data. The recommendations given here can be transposed to other work situations by specialists in health and safety in the workplace.

2. Disinfection of premises

2.1 Definition/field of application

Disinfection of premises consists in full and simultaneous disinfection of all the surfaces in a closed work area, by vaporisation or nebulisation of disinfectant. In addition to vaporising or nebulising, surfaces must be disinfected by wiping. This means of disinfection is, in particular, used in work areas where there is a specific infectious risk (rooms occupied by patients with certain pathological infections) and when there is reason to suspect that disinfection by wiping may not be adequate [1].

Disinfection of work areas is particularly used in the case of some infectious diseases. Examples:

- Anthrax
- Active tuberculosis
- Plague
- Viral haemorrhagic fever (Ebola, etc.)

2.2 Disinfection of premises: general principles

The choice of disinfectant is mainly based on the spectrum of action required from the point of view of hospital hygiene. However, there is no international consensus between experts on the most appropriate procedure for disinfection of work areas. Thus, the Swiss and French favour the use of hydrogen peroxide, whereas the Robert Koch Institute (Germany) considers gaseous formaldehyde to be particularly effective. The Robert Koch Institute underlines that hydrogen peroxide has been used for a few years now, but it is only considered effective enough for use on surfaces which have already been cleaned of any visible soiling [1].

These procedures present a high potential risk for the personnel performing them, and for the work environment. The competencies of the people charged with implementing them are essential, as is respecting the various stages in disinfection (preparation, disinfection, steps to be performed after application). In some countries, there are very strict rules on personnel qualifications and how the operation to disinfect a work area should proceed [2].

2.3 Main procedures used - Example of formaldehyde

Formaldehyde can be applied by vaporisation or nebulisation. However, it is important to verify that enough of the active agent is introduced into the room, and that the relative humidity is sufficiently high. The Robert Koch Institute has established the required conditions as:

- dosage: 5 g of formaldehyde per m^3 of air
- relative humidity of at least 70%
- duration of action: 6 hours

In these conditions, the Robert Koch Institute guarantees the elimination of vegetative bacteria, including mycobacteria, and fungi, including fungal spores, as well as the inactivation of viruses. Only

the spores of some strains (gangrene, tetanus, anthrax) are resistant. For these strains, sterilisation must be performed according to the conditions set out in standards.

Vaporisation of formaldehyde and ammonia in an open system

When vaporising formaldehyde, for example, 50 mL of a 12% formaldehyde solution will be used per m^3 of air. Vaporisers are often equipped with two different reservoirs, one for storage and vaporisation of the formaldehyde solution and the other containing a solution of ammonia (at least 10 mL of a 25% solution per m^3 of air); after contact with the formaldehyde for 6 hours, the ammonia solution is applied to neutralise it.

Disinfection by nebulisation

If the recommendations set out above are followed, formaldehyde and ammonia can also be applied by nebulisation.

2.4 Active ingredients and groups of active ingredients used in disinfectants

Only the procedure described above is considered to be generally effective by the Robert Koch Institute.

EU classification (2014) of formaldehyde (aqueous solution at 35%):

i. Acute toxicity by oral route, cat. 3, H301 Toxic if swallowed
ii. Acute toxicity by skin contact, cat. 3, H311 Toxic in contact with skin
iii. Acute toxicity by inhalation, cat. 3, H331 Toxic if inhaled
iv. Skin corrosion, cat. 1B, H314 Causes severe skin burns and eye damage
v. Skin sensitisation, cat. 1, H317 May cause an allergic skin reaction
vi. Carcinogenic, cat. 1B, H350 May cause cancer
vii. Mutagenic for germ cells, cat. 2, H341 Suspected of causing genetic defects
viii. Specific target organ toxicity - single exposure, cat. 3, H335 May cause respiratory irritation

Classification of ammonia (30% solution):

i. Substances or mixtures causing metal corrosion, cat. 1, H290 May be corrosive to metals
ii. Skin corrosion, cat. 1B, H314 Causes severe skin burns and eye damage
iii. Hazard for aquatic life - acute hazard, cat. 1, H400 Very toxic to aquatic life
iv. Specific target organ toxicity - single exposure, cat. 3, H335 May cause respiratory irritation

2.5 Inhalation exposure, cutaneous exposure

In the premise to be treated by application of a formaldehyde solution and an ammonia solution, airborne concentrations will significantly exceed the current occupational exposure limit (OEL), and will exceed the value currently considered even more (Table 1).

Table 1: OEL [mg/m³] for products used to disinfect work areas (August 2014): (8-h OEL/short-term exposure limit - STEL) [6]

	Germany	France	Switzerland
Formaldehyde	0.37 / 0.72 (MAK value)	0.5 / 1.0 ppm	0.37 / 0.74
Ammonia	14 / 28 (TRGS 900)	7 / 14	14 / 28
Hydrogen peroxide	0.71 (MAK. value)	1.5 / -	0.71 / 0.71

MAK: Maximale Arbeitsplatzkonzentration (maximum concentration at the workstation recommended in Germany on the basis of scientific data, soft regulation)

TRGS 900: Occupational Exposure Limit Values (list of binding limit values in Germany)

The formaldehyde concentration can reach several hundreds of mg/m^3, while that of ammonia considerably exceeds 14 mg/m^3. If workers remain in the work area during disinfection, skin exposure can involve the whole surface of the body. However, this type of exposure would only occur in case of an incident, given that workers are supposed to remain outside the work area during disinfection.

2.6 Risk assessment

Dermal risks:

- - are comparable, during the activities before and after disinfection, to the risks during disinfection by wiping
- - are very high during vaporisation/nebulisation, if the personnel enters the premise

Risks associated with inhalation:

- are high if, in case of leakage, toxic vapours can escape from the premise treated leading to personnel exposure
- are very high (letal concentration possible) during vaporisation/nebulisation, if (unprotected) personnel enters the premise. Opening the door of the room also leads to massive leakage into the environment.

Physical risks:

- N.A.

Other risks:

- N.A.

2.7 Preventive measures

Formaldehyde is used to disinfect premises only in specific cases, when techniques presenting fewer risks for the health of personnel and other people cannot be used, or to meet the requirements of a specific hygiene standard.

Minimum (organisational and technical) safety standards applicable whatever the method used:

1. the risks associated with the method chosen must be assessed,
2. personnel must be trained by a qualified person to alert them to the chemical and biological hazards,
3. appropriate PPE must be available, correctly maintained and looked after. The PPE used must correspond to the risks identified during assessment,

4. medical monitoring of personnel performing disinfection of premises should be performed in line with national regulations,
5. maintenance of the vaporisation/nebulisation devices used should be regular and documented,
6. the ventilation in the premise to be treated, if any, should be turned off and steps taken to ensure that the area is leak-proof,
7. a safety zone should be defined and identified, with access prohibited from neighbouring zones if necessary,
8. the absence of other personnel in neighbouring work areas should be verified,
9. personnel in the surrounding environment who are at risk of exposure hazards must be informed,
10. the extraction system should be reinitialised in a controlled manner after disinfection,
11. emergency intervention steps should be defined.

Personnel should benefit from both theoretical and practical training in the preventive measures to be used so as to be able to apply them correctly. These activities are therefore the subject, in the health care sector (for example in Germany) of specific authorisation. This authorisation can only be delivered by competent authorities if the body requesting them - generally the company contracted for the intervention - has a license indicating their aptitude to perform this type of operation [2]. With regard to the procedure regulating re-entry into the premise after treatment, the person responsible for the disinfection operation should establish, using appropriate measurement systems, that the applicable occupational exposure limit values for formaldehyde and ammonia (see Table 1) are no longer exceeded, and the person who requested the intervention should be informed of this in writing (TRGS 522, paragraph 5.6.2, [2]).

2.8 Use of hydrogen peroxide to disinfect premises

In France and Switzerland, hydrogen peroxide has been substituted for formaldehyde for the disinfection of premises, because of the carcinogenic potential of formaldehyde (substitution).

Hydrogen peroxide can be applied by spraying or vaporisation of aqueous solutions of various concentrations (solutions at a few percent vol/vol, for example).

Hydrogen peroxide solutions (aqueous solutions at x%) are classed as follows:

Oxidising liquids, cat. 1; H271 May cause fire or explosion; strong oxidiser.
Acute toxicity by oral route, cat. 4; H302 Harmful if swallowed.
Acute toxicity by inhalation, cat. 4; H332 Harmful if inhaled.
Skin corrosion, cat. 1A; H314 Causes severe skin burns and eye damage
Serious eye damage, cat. 1; H318
Specific target organ toxicity (single exposure), category 3; H335 May cause respiratory irritation.
Hazard for aquatic life forms, Chronic hazard, cat. 3; H412 Harmful to aquatic life with long lasting effects.

According to the Robert Koch Institute, methods using hydrogen peroxide can sometimes be ineffective in terms of disinfection of premises. Indeed, the efficacy of these procedures depends on the specific conditions found in the premise, the type of procedure and the equipment (generator) used. These methods therefore always require validation on a case-by-case basis prior to their use. Validation can only be delivered for a given work area, procedure and equipment set-up. To perform this validation, the national applicable regulations will be applied (see [4], for example).

3. Disinfection of equipment (e.g. dialysis equipment)

Cleaning of medical equipment poses specific problems due to the risks that the equipment itself

can present, and the specific disinfection procedures to be implemented. The recommendations set out in factsheet 6 for instrument disinfection are not sufficient for equipment, which is larger and more complex. Here, we will present the example of dialysis equipment, which must be disinfected daily in large numbers in dialysis centres and hospitals.

3.1 Definition/field of application

The following recommendations for safety while disinfecting dialysis equipment should be considered as preliminary information, prior to conducting a full assessment of risks, for a work area in which the main activity is blood filtering/performing dialysis on outpatients/inpatients and in which other routine tasks are also performed (e.g. disinfection of surfaces, instruments, hands, skin). Similarly, the risks identified related to the disinfection of dialysis equipment and the recommended preventive measures laid out can only be extrapolated to other types of medical equipment in the context of a case-by-case assessment.

3.2 General considerations

Health care workers in a dialysis centre are exposed to numerous risks (infectious risks linked in particular to contact with blood, risk of pricks/cuts, mental/physical workload and risks linked to the products used). The measures of hygiene applied to protect, in particular, immune-suppressed patients, but also the carers themselves from pathogenic agents (viruses, bacteria, etc.) account for much of the activity of the workers in dialysis centres. To create the required hygienic conditions, surfaces, instruments and equipment must be chemically disinfected. The active ingredients used eliminate infectious agents. If these steps are not performed according to the appropriate procedures, they can represent a risk for the health of personnel.

3.3 Main procedures used

The preparation of dialysis equipment includes cleaning and disinfection. Concentrated products are purchased ready-to-use, and can be connected to the dialysis equipment, which automatically aspirates the product and dilutes it. Treatment of the equipment is thus performed automatically (using a programmed sequence). The system can be considered as a closed system throughout most of the operation. Thus, the product will not be released or come into contact with the skin. The used solution is evacuated through a tube and flows out freely over a short distance. At the end of the disinfection process, this allows verification of the solution before returning the equipment to use. The waste solution can then be eliminated through the normal waste water evacuation circuit. This part of the procedure presents a risk of inhalation for a short duration. During connection and disconnection of the reservoir of concentrated product (approximately every two weeks), the skin may be splashed. The following procedures can be distinguished:

- **Disinfection involving heating and citric acid or hydroxyacetic acid**

  For regular disinfection and descaling, thermochemical procedures at 93°C with concentrated citric acid or concentrated hydroxyacetic acid (25 to 50% weight/weight – w/w) are generally applied. The high temperature results in a brief inhalation exposure during elimination of the waste solution through the waste water evacuation circuit.

- **Disinfection and descaling using peracetic acid**

  Thermochemical procedures can be replaced by non-thermal procedures using peracetic acid (1 to 5% w/vol, up to 35% w/w hydrogen peroxide and up to 10% w/w acetic acid). These procedures are rarely used in dialysis centres today; their use is limited to the treatment of dialysis equipment which has been used by patients with specific infections, and to a specific type of equipment, for which only an acetic acid-based disinfection procedure has been validated. To

meet all the hygiene requirements in dialysis, it is not possible to completely avoid using this substance.

- **Disinfection and scouring using hypochlorites / active chlorine**

  Instruments must also be regularly scoured to remove protein deposits. To do this, non-thermal procedures based on hypochlorite solution or active chlorine (up to 30% w/w) are used.

In other procedures, cartridges replace the recipient containing the concentrated product.

- **Cartridges of citric acid**

  For disinfection and descaling, ready-to-use cartridges of citric acid are available. Crystallised citric acid is dissolved and diluted automatically in the cartridge. Upon completion of the programme, the cartridge is entirely rinsed and dried (automatically). It can then be disposed of. These cartridges are designed for use with a heat-based disinfection programme. There is no risk of exposure to citric acid during the connection/disconnection, nor is there a risk of spilling the solution. For disinfection and scouring, an automatic procedure also exists using sodium carbonate in ready-to-use cartridges. Sometimes, empty cartridges are filled with 50% citric acid using a special device. During pressurised filling, splashes of the solution may be emitted if there is a problem with the device.

3.4 Main active ingredients and groups of disinfectants

The main ingredients in this class of disinfectants are citric acid, hydroxyacetic acid, acetic acid, peracetic acid, hydrogen peroxide and hypochlorites. For further details on their properties, please refer to the annex to factsheet 3 (except for hydroxyacetic acid). All of these products present an acute toxicity. If the undiluted product comes into contact with the skin or splashes are received in the eye, most of them can cause burns on the skin and serious eye damage. Peracetic acid and sodium hypochlorite can cause damage to, or permanent clouding of the cornea.

Hydroxyacetic acid and citric acid are odourless and have a low volatility at ambient temperature, thus they barely evaporate from solution in these conditions. These products can only cause irritation of the airways if they are used in high-temperature procedures, or if aerosols or dusts are formed.

Hypochlorite solutions smell strongly of chlorine. It is important to take into account the emission of chlorine when using this product, particularly if it is accidentally mixed with acids.

Peracetic acid releases a sharp smell of acetic acid. Vapours and aerosols of this acid are potentially irritating for the respiratory mucosa and the eyes. Peracetic acid and hydrogen peroxide are also acutely toxic by inhalation, and peracetic acid is toxic in contact with the skin (risk of transdermal penetration, according to some manufacturers). Some data indicate that peracetic acid could have a carcinogenic effect, these data will need to be confirmed.

Acetic acid, peracetic acid and hydrogen peroxide also present risks of fire and explosion. Peracetic acid and hydrogen peroxide are strong oxidants, and are highly reactive. It is enough for them to be in contact with small quantities of impurities to cause their decomposition. Inappropriate use or storage can cause the formation of gases, with a risk of spontaneous inflammation.

NB: any contact between hypochlorite and acid triggers a chemical reaction with formation of toxic chlorine gas.

3.5 Analysis of inhalation exposure and cutaneous exposure

Assessment of the risks to which workers are exposed during operations involving the use of ready-to-use products is carried out on the basis of the

labelling provided by the manufacturer. During the preparation of dialysis equipment, aqueous solutions are used. Connecting/disconnecting the reservoir of concentrated product can produce splashes leading to irritations/burns on the skin and mucosa. Inhalation exposure causing irritation of the airways is also possible.

For a full study of the hazards, it is important to take into account operations before and after disinfection (maintenance of the dialysis equipment in the workshop or at workstations for intermediate disinfection after long periods during which the equipment was not used, interventions in case of technical failure), as well as inappropriate use.

3.6 Risk assessment

The risks for workers in a health care setting can be assessed as follows:

Dermal risks:

Dermal risks can be classed in three categories (low, moderate, high) based on information relating to product categories [5]. The following information is necessary for this classification: dangerous properties of the product according to the manufacturer's label, extent and duration of skin contact. In the case of dialysis equipment, the operations undertaken lead to skin contact lasting less than 15 minutes, generally involving a small area (splashes). Application of the hazards matrix (Table 3 in factsheet 2) to automated disinfection of dialysis equipment produces the following assessment:

- no risk when operations are performed with citric acid.
- low risk when operations are performed using concentrated products containing up to 1% peracetic acid.
- moderate risk when operations are performed using concentrated hydroxyacetic acid, hypochlorites/active chlorine, and high concentrations of peracetic acid.

It is also important to take the ocular risk into account.

Risks associated with inhalation:

To assess the risks associated with inhalation, the airborne occupational exposure limit values presented in Table 2 can be used.

Table 2: Disinfection of dialysis equipment: active ingredients used and occupational exposure limit values for the airborne concentration of the various components. The values per shift/ for short exposure times are given in [mg/m^3] [6].

CAS No.	Active ingredient	Germany	France	Switzer-land	DNEL for pro-longed exposure by inhalation [7]
7782-50-5	Chlorine	1.5/1.5	-/1.5	1.5/1.5	loc 0.75 sys 0.75
64-19-7	Acetic acid	25/50	-/25	25/50	loc 25
79-14-1	Hydroxyacetic acid	-/-	-/-	-/-	loc 1.53 sys10.56
7681-52-9	Sodium hypochlorite (bleach)	-/-	-/-	-/-	loc1.5 sys 1.5
79-21-0	Peroxyacetic acid / Peracetic acid	-/-	-/-	-/-	loc 0.6 sys 0.6
7722-84-1	Hydrogen peroxide	-/- 0.71 (MAK)	1.5/-	0.71/0.71	loc 1.4

DNEL: Derived No Effect Level loc= localised effects sys= systemic action

Obligatory occupational exposure limit values have been established for chlorine, acetic acid and hydrogen peroxide. These volatile substances can penetrate the airways in the form of gas or vapours. In a dialysis department there are no risks linked to acetic acid given its high occupational exposure limit value. Although acetic acid is used in a wide variety of sectors, few cases of disorders due to repeated exposure by inhalation or by skin contact have been reported [8]. We do not have any data relating to occupational exposure to hydrogen peroxide; in Germany there is only a recommended OEL (MAK) for hydrogen peroxide. The occupational exposure limit value for chlorine makes it possible to assess the risks related to inhalation when using hypochlorite solutions. If these products are accidentally mixed with acids, the OEL for chlorine can briefly be exceeded. For substances without an OEL, guidance can be obtained from the DNEL values (Derived No Effect Level) for prolonged exposure by inhalation, which manufacturers are required to provide [7], or from other values based on scientific criteria, such as TRV (toxicological reference values) [7].

Physical risks

Disinfection procedures involving heat present a risk of injury due to splashing with hot liquids. In this context, we would like to insist that cleaning the outside of a device by wiping - which is not covered in this factsheet - should only be performed once the equipment has cooled down.

The oxidising action of concentrated peracetic acid should particularly be considered when assessing risks related to disinfection tasks. For organic peroxides which spontaneously decompose (R5 according to the CLP regulations + labelling with

H240, 241 or 242), specific fire safety and storage measures must be implemented (in Germany: [9, 10]). However, a study of the German market performed in 2010 revealed that the peroxide solutions commonly used to clean dialysis equipment did not carry this hazard warning, and were therefore not subject to the obligation to implement specific fire prevention measures.

3.7. Preventive measures

When considering substitution, it is important to take into account the constraints linked to hygiene and the procedures validated by the equipment manufacturer.

- Replace procedures involving peracetic acid and hypochlorite by thermochemical procedures.
- Use thermochemical procedures in the following order of preference: citric acid in ready-to-use cartridges > citric acid > hydroxyacetic acid
- When equipment cannot be disinfected using a thermochemical procedure, use a product containing a low percentage of peracetic acid.
- To eliminate protein deposits, hypochlorites are the only option. Reduce the amounts and frequency of use as far as possible, in line with the equipment manufacturer's recommendations.

The following checklist can be used to verify whether the required technical, organisational and individual prevention steps are effectively applied when preparing dialysis equipment. When using cartridges of citric acid, no specific preventive measures need be applied.

- When preparing equipment, verify that ventilation in the work area conforms to industry standards (e.g. ventilation is installed).
- Take into account, for this type of installation, exposure to disinfectants and emission of heat by equipment, as well as the minimum volumes of outside air required for rooms in which interventions and examinations are performed (in Germany, 40 m^3/h per person, according to standard DIN 1946, part 4 [11]).
- If natural ventilation (e.g. a window) is the only source of fresh air, verify that ventilation is always available (including in winter), and determine how long ventilation phases need to last. When the doors and windows are closed, in winter, air is renewed at around 0.2 volumes per hour, thus for a 50 m^3 room, only 10 m^3 of air are replaced every hour by fresh air. During operations to prepare equipment, which lead to release of product, the doors and windows should be opened (and transverse ventilation should be used if possible).
- Reservoirs should be directly connected to the dialysis equipment using a leak-proof adapter provided by the manufacturer/supplier.
- When placing a reservoir of peracetic acid, take into account that it must be protected from excessive heat and from direct sunlight.
- Products containing citric acid, hydroxyacetic acid and peracetic acid should always be handled away from products containing hypochlorites. These products should not be evacuated together in uncovered waste collection containers when simultaneously preparing several devices in the workshop, or at intermediate disinfection workstations where equipment is prepared after long periods of not being used.
- Products containing peracetic acid or hypochlorites should never be used with programmes including a hot cycle.
- Oxidising disinfectants with a high peracetic acid or hydrogen peroxide content should never be reconditioned in other containers, and residues should never be tipped back into the reservoir. This is because even very small amounts of impurities are enough to cause their decomposition.

- Keep a supply of chemical binder to hand in case of accidental spillage of the concentrated product. When small quantities (up to approximately 0.5 L) are spilled, dilute with a large amount of water (around 2.5 L) and wipe up with a clean cloth. To avoid the risk of spontaneous inflammation, never wipe up undiluted oxidising disinfectants containing a high concentration of peracetic acid or hydrogen peroxide with paper, cellulose or dirty cloths.
- If hand contact is unavoidable, wear gloves made from an appropriately resistant material. If, during replacement of a reservoir, concentrated corrosive products (hydroxyacetic acid, peracetic acid, hypochlorites) may be splashed or spilled on the forearms, the protective gloves must have a long cuff. The manufacturer's information can be found on the material safety data sheet.
- If there is a risk of splashes of concentrated product to the eyes, e.g. during connection/ disconnection of the reservoir from a dialysis machine, wear safety glasses with side shields. This recommendation also applies when using cartridges filled with 50% citric acid in a specialised system, since during filling under pressure, splashes are possible if, for example, the system malfunctions.
- Use disposable aprons as personal protection when reservoirs containing concentrated corrosive products must be changed and this operation entails a risk of accidental spillage.
- For first aid, install eye wash units (EN 15154, part 2 [12]). They should be checked monthly to ensure that they are functioning correctly.
- In case of accident, such as leakage of large amounts of concentrated product (e.g. peracetic acid, hypochlorites), respiratory protection (appropriate respiratory protection: ABEK-P2 or combined P3 filters), gloves with protective cuffs, disposable aprons and protective glasses must be available.

4. Disinfection of linen and clothing

4.1 Definition/field of application

Some textiles used in the healthcare sector have to be disinfected (or undergo disinfectant washing) so as to prevent the transmission of pathogenic agents. These operations are often performed in laundries specialised in the treatment of hospital linen and clothing and treating large volumes in automatic systems working continuously. Alternatively, disinfectant washing can also be performed manually or in washing machines in healthcare establishments, medical practices or hospitals. When using chemical or thermochemical washing procedures, it is necessary, as with any disinfection procedure, to assess the risks linked to the chemicals used and to take appropriate preventive measures.

4.2 Main procedures used

The main disinfection procedures used with linen and clothing are the following:

- boiling
- disinfectant washing in a machine

Washing machines must be compatible with the concentration of disinfectant and detergent, the fabric to water weight ratio and the temperature prescribed for the procedure implemented throughout the duration of action of the products. The water weight designates the amount of water used to treat the linen and clothing during an active washing phase. The fabric to water weight ratio corresponds to the ratio between the weight of the fabric and the weight of the water used. The values given for the fabric to water weight ratio are minimum values. Higher values can also be used. [1]

At the end of the disinfection phase, the linen and clothing, the water and the inside of the machine which was in contact with the contaminated textiles and the washing water must be disinfected. The washing water must not be emptied before disinfection has been completed. Contaminated air

must be extracted or treated so that it does not present a risk.

Based on current knowledge, these requirements can be respected if the following types of machine are used:

- Machines with a drum capable of discontinuous movement (domestic machines are generally not appropriate).
- Machines with continuous movement which have been approved for disinfection of linen and clothing by an official organisation (e.g. Robert Koch Institute in Germany).

4.3 Main active ingredients and groups of active ingredients used in disinfectants

The main groups of active ingredients used to disinfect linen and clothing are peroxide-based compounds, and for specific disinfection tasks, chlorine -based compounds. The list of disinfectants and disinfection procedures authorised in Germany (Robert Koch Institute, 2013 list [1]) contains, for example, 55 procedures with peroxide-based compounds and only two using active chlorine as the active ingredient. Peroxide-based compounds are, for example, peracetic acid, hydrogen peroxide, sodium perborate or more complex compounds releasing peracetic acid. Other additives include organic acids (e.g. acetic acid, benzenesulfonic acid, citric acid), bases and silicates. Because of these active ingredients, many products for linen and textile disinfection are classed as corrosive or irritant.

Some compounds may also contain products such as glyoxal, glutaraldehyde, formaldehyde or 4-chloro-3-methylphenol, which are classed as skin or respiratory sensitisers [13].

4.4 Inhalation exposure, cutaneous exposure

Various stages in the disinfection of linen and clothing can lead to skin exposure:

- connection and disconnection of reservoirs of concentrated product to/from washing machines/automated washing stations
- transfer of concentrated product (from one container to another)
- manual transfer of concentrated product to a container or machine
- soaking and removing linen and textiles from a wash tub
- elimination of the waste solution

These activities can also lead to inhalation exposure due to the formation of aerosols or vapours.

4.5 Risk assessment

For a full description of the risks linked to the active ingredients / groups of active ingredients, see Factsheet 3.
Products containing peracetic acid are characterised by an acrid smell of acetic acid. Products containing hypochlorites have a characteristic pungent smell of chlorine.

Risks resulting from skin contact

Direct contact with concentrated products can, depending on the ingredients they contain, lead to irritations or burns to the skin or mucous membranes. Prolonged contact with the solution used / the diluted product can lead to skin irritation such as irritative dermatitis. Splashes to the eyes can cause corneal damage or even, in some circumstances, permanent corneal opacification. Finally, products containing sensitising substances (e.g. aldehydes) can cause allergic contact dermatitis.

Risks associated with inhalation

Aerosols, dusts and vapours are irritants for the airways. The use of products containing substances classed as sensitisers for the airways (e.g. glutaraldehyde) can trigger allergic rhinoconjunctivitis and allergic asthma.

To assess the risks associated with inhalation, we use the airborne occupational exposure limit values presented below.

Table 3: Ingredients in disinfectants destined for use with linen and textiles with an OEL in France, Switzerland or Germany, and for some, in other countries (source: International list of occupational exposure limit values from the GESTIS information system on dangerous products, set up by DGUV; consulted: August 2013). The occupational exposure limit values (in mg/m^3) are applicable for the duration of a work shift/for short-term exposure.

CAS No.	Compound	Germany	France	Switzerland	Various
50-00-0	Formaldehyde	0.37/0.74 (MAK)	0.5/1 ppm	0.37/0.74	
59-50-7	4-Chloro-3-methylphenol	-/-	-/-	-/-	3/6 Sweden
64-19-7	Acetic acid	25/50	-/25	25/50	
107-22-2	Glyoxal	-/-	-/-	-/-	0.5/0.5 Denmark 0.1/- Belgium, Canada-Ontario, Spain
111-30-8	Glutaraldehyde	0.2/0.4	0.4/0.8	0.21/0.42	
7722-84-1	Hydrogen peroxide	0.71/- (MAK)	1.5/-	0.71/0.71	
7782-50-5	Chlorine	1.5/1.5	-/1.5	1.5/1.5	

Apart from these occupational exposure limit values for airborne concentrations, MAK values should be taken into account by occupational physicians and toxicologists as part of their assessment. They are indicated in the table above for formaldehyde and hydrogen peroxide.

Physical risks:

For high-temperature washing, the risk of burns should also be considered.

Other risks:

Accidental mixing of sodium hypochlorite with acids (e.g. peracetic acid) leads to release of heat and the formation of toxic and irritant chlorine-based compounds.

Poor use or inappropriate storage of oxidising disinfectants can lead to the formation of spontaneously flammable gases.

4.6. Preventive measures

- Sort linen and clothing in the department where it is used, if possible based on the planned washing and treatment procedures. Identify the different types of linen and clothing and the corresponding containers.
- Any subsequent sorting of soiled/used linen and clothing should be prohibited.
- Collect and transport used linen and clothing in cloth or tear-resistant plastic sacks. Sacks should be sufficiently germ-proof and if possible waterproof.
- In the hygiene plan, include appropriate steps to clean and disinfect the trolleys used to transport linen and clothing.
- Only use disinfectants which are effective against the infectious agent to be eliminated ("confirmed as efficacious disinfectants").
- Prepare the disinfectant solutions at the prescribed dilution.
- Conform to the fabric to water weight ratio (weight of the linen and clothing in kg/amount of liquid (water + chemicals) in litres - e.g. 1:8).
- Adhere to the prescribed minimum soaking duration.
- Carefully rinse linen and clothing to eliminate residual detergent and disinfectant.

- Prevent transfer of infectious agents from dirty linen and clothing to clean linen and clothing.
- Supply the required personal protective equipment based on risk assessment, and ensure that it is used. This particularly applies to protective gloves, according to the manufacturer's indications, safety glasses (for splashes) and any appropriate aprons or waterproof shoes. The indicated personal protective equipment should be used during the following operations:
    - connection and disconnection of reservoirs of concentrated product to/from washing machines/automated washing stations: protective gloves + safety glasses,
    - transfer of concentrated product (from one container to another): gloves + glasses + protective apron,
    - manual transfer of concentrated product to a recipient or machine: gloves + protective glasses,
    - soaking and removing linen and textiles from a wash tub: protective gloves,
    - elimination of the waste solution from reservoirs: gloves + glasses + protective apron,
- Personnel should be informed of the risks and appropriately trained at regular intervals.

5. Medical prevention

Medical monitoring of workers differs depending on the country where they work and the applicable national regulations. Where surveillance is organised by occupational health departments, or preventive examinations are performed by occupational physicians, workers responsible for disinfection tasks should be informed of the potential risks to their health related to using disinfectants and of certain rules of hygiene, in particular by drawing their attention to the following points:

- Early symptoms of skin, eye and respiratory disorders
- Individual risk factors
- History of allergy
- Risks linked to wearing gloves for prolonged periods
- Recommendations for cleaning, drying and caring for the skin

In Germany [2] and France, workers responsible for the disinfection of work areas are subject to special medical monitoring. In Switzerland, they are covered by the general regulations relating to medical monitoring of personnel.

Occupational medicine should also take into account other aspects such as the prevention of infectious risks. These aspects are not covered in this factsheet.

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Use of disinfectants in the health care sector: Chemical hazards and preventive measures

Factsheet 8: Specific disinfection procedures (premises, medical equipment, linen and clothing)

12/2014

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