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

## Factsheet 5: Surface disinfection

**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. Definition/field of application

Surface disinfection aims to reduce the number of microorganisms capable of multiplying on the surface, by killing or inactivating them. This impedes their propagation and thus prevents transmission of pathogenic agents to patients and personnel.

In care institutions, disinfection is applied to floors and walls, work surfaces, and the surfaces of furniture and medical equipment. Surface disinfection is routinely practiced, in line with the recommendations for hospital hygiene, or is used in a targeted approach to treat zones visibly soiled with blood, other biological fluids or secretions.

Disinfectants are used in aqueous solution and are often combined with cleaning products such as detergents or enzymes for “disinfectant cleaning”.

In some cases, for example to combat specific infectious events, it may be necessary to resort to procedures (or to concentrations and/or durations of action) differing from routine disinfection procedures [1].

## 2. General principles

Disinfectants are selected above all for the spectrum of action required from the point of view of hospital hygiene. Only disinfectants included on the national lists of authorised/effective products should be used (e.g. lists from the Robert Koch institute (2013) and the Association for applied hygiene (Verbund für angewandte Hygiene e.V) [2, 3] in Germany, positive list from the French society for hospital hygiene (Société française d’hygiène hospitalière, SF2H [4]) and the ProdHyBase database [22] in France, and the Public Product Register published by the Federal office for public health (Bundesamt für Gesundheit) in Switzerland [5]). Attention should be paid to the recommended concentrations to avoid microorganism selection and inducing tolerance or resistance to disinfectants. However, it is important not to neglect the prevention of occupational risks when choosing disinfectants. For this, occupational physicians and other OSH professionals should be consulted when selecting disinfection procedures.

This factsheet deals with disinfection with a view to preventing occupational risks.

## 3. Main disinfection procedures

The chemical procedures described here only represent a proportion of the different procedures potentially employed (e.g. thermal or physical disinfection, UV irradiation). However, in the health care sector, surface disinfection mainly revolves around the use of chemical procedures.

In a systematic risk analysis, all the steps in surface disinfection should be assessed, including the operations preceding and following disinfection itself. The main steps are as follows:

- A working solution is prepared from a concentrated stock solution,
- The disinfectant is applied (with a cloth, mop, etc.),
- The remaining solution and the soiled utensils (cloth, mop) are disposed of.

### a. Disinfection by damp mopping/wiping

With disinfection by mopping/wiping, an aqueous disinfectant solution is generally applied to the surfaces to be disinfected applying slight pressure and rubbing. After the prescribed duration of action, the excess disinfectant solution is removed. Various materials are used: cloths or similar for manual application, equipment such as a mop and double-bucket, or electric floor scrubbers.

The working solution is often prepared from a concentrated stock solution. Any remaining working solution should be disposed of and brushes and other utensils should either be disposed of or sent for cleaning.

### b. Disinfection by spraying

Spray disinfection involves spraying an aerosol of disinfectant onto the surfaces to be treated. This results in personnel exposure by inhalation. The principles of occupational risk prevention thus lead us to advise against this procedure. However, it

remains frequently used for rapid disinfection of small surface areas. Because of the irregular application of the disinfectant on the surfaces and its practically immediate removal by wiping, the process is unlikely to be effective. Therefore, we advise against it both to prevent occupational exposure and from the standpoint of hygiene.

## 4. Main active substances and groups of active substances in disinfectants

The ingredients in products for surface disinfection vary depending on the cleaning and disinfection tasks to be performed. The main groups of active substances used are the following:

- Alcohols (ethanol, 1-propanol, 2-propanol)
- Aldehydes (formaldehyde, glutaraldehyde, glyoxal)
- Quaternary ammonium compounds
- Guanidines/Biguanides
- Alkylamines (e.g. glucoprotamine)
- Peroxides
- Glycols and derivatives
- Phenol and derivatives

A systematic study of the products available on the German market led to a detailed analysis of the active compounds indicated by manufacturers. The most frequently used are listed in **Table 1**.

**Table 1:** Most commonly used active substances in the 478 surface disinfectants included in the study, according to the information provided by manufacturers. Data gathered in 2010 [6].

| Substance | CAS No. | Group of active substances | Number of disinfectants containing the substance |
|---|---|---|---|
| 2-Propanol | 67-63-0 | Alcohols | 181 |
| Didecyl dimethyl ammonium chloride | 7173-51-5 | Quaternary ammonium compounds | 166 |
| Ethanol | 64-17-5 | Alcohols | 135 |
| Alkyl benzyl dimethyl ammonium chloride | 68391-01-5 | Quaternary ammonium compounds | 95 |
| 1-Propanol | 71-23-8 | Alcohols | 87 |
| N-Alkyl-N-ethylbenzyl-N,N-dimethyl ammonium chloride | 85409-23-0 | Quaternary ammonium compounds | 59 |
| Branched tridecylalcohol, ethoxylated | 69011-36-5 | | 42 |
| Glutaralaldehyde | 111-30-8 | Aldehydes | 40 |
| N-(3-Aminopropyl)-N-dodecylpropane-1,3-diamine | 2372-82-9 | Alkylamines | 39 |
| Alkyl dimethyl benzyl ammonium chloride | 68424-85-1 | Quaternary ammonium compounds | 38 |
| Glyoxal | 107-22-2 | Aldehydes | 30 |
| Polyhexamethylene biguanide hydrochloride | 27083-27-8 | Guanidines | 27 |
| Ethylene diamine tetracetic acid, tetrasodium salt | 64-02-8 | | 24 |
| Nitrilotriacetic acid, trisodium salt | 5064-31-3 | | 19 |
| Formaldehyde | 50-00-0 | Aldehydes | 18 |
| 2-(2-Butoxyethoxy)ethanol | 112-34-5 | Glycols and derivatives | 15 |
| Hydrogen peroxide | 7722-84-1 | Peroxides | 12 |
| Alcohols, C9-11, ethoxylated | 68439-46-3 | | 12 |
| Isodecyl alcohol ethoxylated | 61827-42-7 | | 12 |
| Sodium carbonate | 497-19-8 | Bases | 10 |
| Citric acid | 77-92-9 | Acids | 9 |
| Ethanolamine | 141-43-5 | Alcohols | 9 |
| 2-Phenoxyethanol | 122-99-6 | Glycols and derivatives | 8 |
| Sodium-2-ethylhexylsulphate | 126-92-1 | | 8 |
| Nitriloacetic acid | 139-13-9 | | 8 |
| Citric acid (monohydrate) | 5949-29-1 | Acids | 8 |

Of the 478 surface disinfectants examined, labelling on the product indicated the following dangerous properties:

- irritant (Xi) = 40.2%
- corrosive (C) = 27.4%
- harmful (Xn) = 3.8%
- highly/extremely inflammable (F, F+) = 4.6%
- oxidising (O) = 1.0%
- dangerous for the environment (N) = 12.6%

In addition, 62 surface disinfectants (i.e. 13.0%) were classed as skin or respiratory sensitisers, of which 24 (5.0%) were skin sensitisers (risk-phrase R43), 5 (1.0%) were respiratory sensitisers (R42), and 33 (6.9%) were skin and respiratory sensitisers (R42/43).

17 products also carried the R40 risk phrase "Suspected carcinogen".

The remaining 124 products, i.e. 25.9% of disinfectants, carried no hazard labels.

## 5. Exposure by inhalation and by skin contact

During surface disinfection, when using concentrated or diluted disinfectants, the intake of hazardous substances by inhalation or by skin contact (dermal exposure) is possible (also see Factsheet ).

The level of exposure by inhalation during surface disinfection particularly depends on the following factors:

- procedure used
  During disinfection by damp mopping/wiping, the mechanical application of the product can cause droplets to be projected. Compared to disinfection by spraying, however, during which all of the product is projected as an aerosol, droplet formation is generally negligible with disinfection by damp mopping/wiping. Inhalation exposure is only possible when the ingredients in the disinfectants have a high vapour pressure and are therefore present in the air inhaled by workers.
- physical properties of the ingredients
  Among the disinfectants listed, the aldehydes (e.g. formaldehyde, glutaraldehyde, glyoxal), the alcohols (e.g. ethanol, propanols) and the peroxides (hydrogen peroxide) are the main compounds with a vapour pressure potentially leading to significant inhalation exposure. As vapour pressure rises with temperature, it is important never to use hot water to dilute concentrated products. Nevertheless, the actual level of exposure depends on other factors too.
- concentration of the ingredients
  The concentration of the active substances in the concentrated stock solution should not be used to determine personnel exposure, as the working solution is often diluted down to 0.25%, 0.5% or, for terminal disinfection, to around 3%. It is therefore the concentration of the substances in this solution that should be examined.
- the surface area to be disinfected, and amount of solution used
  When a substance evaporates into the atmosphere, the substance emission rate is proportional to the area of the wet (damp) surface. The amount of disinfectant solution used can also affect evaporation, as very wet surfaces require longer to dry than surfaces cleaned with a small amount of product.
- volume of the room
  Substances emitted into the atmosphere are in theory distributed throughout the available volume. If the room is poorly or not ventilated, the atmospheric concentration [mg/m³] can be assessed by dividing the mass of evaporated substance [mg] by the volume of the room [$m^3$].
- ventilation of the room
  If the ventilation of the room $\lambda$ is not negligible, i.e., $\lambda \geq 0.1$ room volume/hour, the products emitted are extracted from the room by ventila-

tion, and a steady state will be reached. The concentration in the air of the room [mg/m³] can thus be calculated by dividing the amount of substance used [mg/h] in the room by the flow of fresh air introduced into the room [$m^3$/h].

- duration of exposure
  Personnel exposure does not depend solely on the duration of substance emission into the atmosphere of a room, but also on the time that workers spend in a polluted atmosphere.
- position relative to the disinfected surface
  The concentration distribution over time or relative to worker position should be considered. Workers whose workstation is placed close to a source of dangerous products may be more exposed than those who move about within the zone, or who work at a distance from the source of emission.

The level of skin exposure depends mainly on the following factors:

- substance concentration
  The concentration affects both localised cutaneous effects and systemic effects (e.g. effects on some organs).
- area of skin in contact with the product
  Both for localised effects (irritation, corrosion, reactions due to sensitisation) and for penetration of the product through the skin, the area of skin in contact with the product plays an important role. In addition, contact due to projections should be distinguished from contact with the whole surface of the skin (e.g. when the hand is dipped into a disinfection bucket or basin).
- duration of contact
  While contact due to projections is generally short-lived, exposure is more significant when skin contact persists during relatively prolonged activities, such as disinfection of surfaces using a product-soaked cloth. In Germany, the TRGS 401 [7] distinguishes between short-term skin contact (< 15 minutes) and prolonged contact (≥ 15 minutes), and lays out different preventive measures for each case.

Apart from the factors indicated above, inter-individual differences should also be taken into account for both inhalation and dermal exposure. Operators' experience in the tasks assigned to them, or differences in behaviour (tolerance with regard to projections or puddles of product) can influence exposure.

## 6. Risk assessment

The risks described above can be assessed as follows:

### Risks resulting from skin contact

In the absence of preventive measures, manual disinfection of large surface areas can lead to prolonged periods of contact between the skin and the chemicals present in cleaning and disinfection solutions. Because of the irritant and corrosive properties of many concentrated disinfection and cleaning products, manipulation of concentrated products poses a particular risk of acute skin irritation. This risk is at its highest when preparing disinfectant solutions from a concentrated product. Working solutions are generally obtained by adding water to a concentrated product, which is diluted 20- to 200-fold, and thus present a lower potential acute effect. However, these dilute solutions are regularly used over long periods, which carries a risk of inducing chronic dermatitis.

The active substances can also be absorbed through the skin. However, given the conditions of exposure in real-life situations (intensity and duration) during disinfection of surfaces, systemic effects such as damage to organs or neurological lesions are not likely to occur, and have not been mentioned in the literature.

Given the high sensitising potential of a large number of surface disinfectants, the risk of inducing allergic contact eczema should be taken seriously. This risk is present both during manipulation of the

concentrated and the dilute forms of a product. In addition, other ingredients contained in the disinfectant may promote the absorption of allergenic compounds. However, the different groups of active compounds found in disinfectants have different sensitisation potentials, and products containing aldehydes or quaternary ammonium compounds are more likely to be classed as sensitisers.

**Risks associated with inhalation**

Only a few of the many substances used in surface disinfectants have an occupational exposure limit (see **Table 2**). Because of this, exposure data can only be qualitatively assessed.

With inhalation exposure, there is a risk of acute or chronic irritation of the respiratory tract and ocular mucous membranes, as well as a risk of respiratory allergies due to specific sensitisation. Due to their high vapour pressure, aldehydes used in disinfectants (formaldehyde and glutaraldehyde) can act on the respiratory tract. In contrast, biguanides and quaternary ammonium compounds have a low vapour pressure. These can only be inhaled if the procedures used give rise to aerosol formation. The risks of inhalation exposure increase when aerosols are formed during disinfection operations, particularly with spray-based targeted disinfection, or when concentrated disinfectant solutions are handled.

When disinfectants are inhaled (in particular with intensive use of aldehyde- or alcohol-based products) systemic effects cannot be excluded, but they are not very likely in practice.

**Table 2:** Substances with an occupational exposure limit in France, Switzerland and Germany, and for some in Denmark, found in surface disinfectants (source: "Liste Internationaler Grenzwerte" of the “Gefahrstoffinformationssystem GESTIS” of the German DGUV, as of August 2013). The limit values (in mg/m$^3$) are applicable for the duration of a work shift/for short-term exposure.

| CAS | Substance | Germany | France | Switzerland | Other |
|---|---|---|---|---|---|
| 50-00-0 | Formaldehyde | -/- | 0.5/1 ppm | 0.37/0.74 | |
| 64-17-5 | Ethanol | 960/1920 | 1900/9500 | 960/1920 | |
| 67-63-0 | 2-Propanol | 500/1000 | -/980 | 500/1000 | |
| 71-23-8 | 1-Propanol | -/- | 500/- | 500/- | |
| 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 | |
| 112-34-5 | 2-(2-Butoxyethoxy)ethanol | 67/100 | 67.5/101.2 | 67/101.2 | |
| 122-99-6 | 2-Phenoxyethanol | 110/220 | -/- | 110/220 | |
| 141-43-5 | Ethanolamine | 5.1/10.2 | 2.5/7.6 | 5/10 | |
| 7722-84-1 | Hydrogen peroxide | -/- | 1.5/- | 0.71/0.71 | |

**Physical risks**

Alcohol-based disinfectants are often classed as highly flammable (F) or extremely flammable (F+). When using alcohol-based products, on large surface areas in particular, it is important to be aware of the risk of fire and explosion. Products containing peroxides (e.g. hydrogen peroxide, peracetic acid) release oxygen, and can thus have an oxidising effect.

These risks should be considered during product use and storage.

**Other risks**

Risk assessment should be performed by the company in line with the national regulations, if necessary with assistance from occupational physicians or other occupational safety and health (OSH) specialists.

Beyond chemical factors, surface disinfection presents other sources of exposure risks, and hazards for personnel. This will not be treated in detail here, but it is important to keep them in mind when assessing risks:

- Infectious risks
- Risks of injury from sharp or pointed objects
- Musculoskeletal disorders due to manual handling of heavy loads and incorrect posture
- Wet work

**Risk assessment (data from the literature):**

For more details on the potential hazards associated with chemical disinfectants, please see factsheet 3 from the current series.

In the literature, the most commonly reported risks described in combination with the use of disinfectants are the risk of irritation of the skin and eye mucosa or the upper and lower respiratory tract, and allergic reactions as a result of immediate or delayed sensitisation.

Recent epidemiological studies show that workers in the health care sector who are exposed to cleaning and disinfection products present an increased risk of work-related respiratory disorders, occupational or work-related asthma [8, 9, 10, 11]. Kogevinas and collaborators [12] observed a significantly increased risk (RR 2.2) for health care workers (IC 95% 1.3-4.0, p = 0.007) in a prospective study of new cases of bronchial asthma in various professions. However, these effects do not always occur in the context of surface disinfection activities; most studies of the risks linked to chemical disinfectants relate to instrument disinfection.

Many additional elements indicate that using surface disinfectants may present risks. For health care workers, high rates of respiratory disorders are described in relation to surface cleaning and disinfection operations. Arif et al. [9] indicate a relative risk of bronchial asthma of 1.74 (IC 95% -2.94), while Delclos et al. [13] show a relative risk of 2.02 (IC 95% 1.20-3.40). For symptoms of bronchial hyperreactivity, Arif et al. assess the relative risk at 1.57 (IC 95% 1.11 – 2.21) and Delclos et al. at 1.63 (IC 95% 1.21-2.19).

Respiratory disorders due to irritation or immediate -type sensitisation are mainly seen with disinfectants which have a high vapour pressure, in particular those containing aldehydes. But quaternary ammonium compounds, which have a low vapour pressure, have also been linked to the onset of bronchial asthma in the literature. Purohit et al. [14], in particular, report on three cases of occupational asthma with a specific confirmed reaction to quaternary ammonium compounds, of which two were related to surface disinfection. The mechanisms triggering this reaction remain to be determined.

Disinfectants with a low vapour pressure can also cause respiratory disorders, in particular if they are used as sprays, producing aerosols. Hemery [15] very explicitly evokes this risk, including for quaternary ammonium compounds. Laborde-Castérot and collaborators [16] were the first to report a se-

ries of cases. They described 10 patients (maintenance or health personnel) suffering from rhinitis or asthma following the use of spray-on cleaning or disinfection products containing EDTA (ethylene diamine tetracetic acid) as a complexing agent. The other compounds contained in these sprays were not indicated.

Disinfectants can be a significant source of risks for the skin. Kiec-Swierczynska et al. [17] examined 223 health care workers for whom a skin affection was suspected to be of occupational origin. Contact allergy was established for 66.4% of these cases. Delayed-type sensitisation to disinfectants most often involved quaternary ammonium compounds (23.8%), followed by formaldehyde (20.6%), glutaraldehyde (10.8%) and glyoxal (4.9%) .

Schliemann et al. [18] report on a case of contact allergy to quaternary ammonium compounds used in surface disinfection procedures in an operating theatre. Mauléon et al. [19] describe a case of pronounced contact eczema following inhalation of aerosols of disinfectants produced by accidental spills. In this case, delayed-type sensitisation to quaternary ammonium compounds was established.

To determine the significance of glyoxal as a contact allergen, Uter et al. [20] performed a retrospective analysis of occupationally-induced allergic contact eczema. In a significant number of those tested, contact sensitisation to glyoxal was established, often at the same time as sensitisation to glutaraldehyde and formaldehyde. These patients often performed duties including both cleaning and disinfection operations.

Rideout et al. [21] studied hospitals in British Columbia where the most commonly used aldehyde-based disinfectants were replaced by substitute products to reduce the risks linked to their composition. The substitute products most often contained orthophtalaldehyde (OPA, another aldehyde) or mixtures of peroxide and peracetic acid. Replacement products were adopted by 51% of hospitals. An assessment of the health risks - based on a full bibliographic study, manufacturer's data and analysis of toxicological data - showed that all the products were potential skin and respiratory irritants, and that OPA also had a sensitising potential; in contrast, sensitisation to peroxides or peracetic acid has never been described. The risks linked to the substitute products, according to these authors, remain poorly known.

## 7. Preventive measures (STOP)

The following types of exposure should be avoided during surface disinfection:

- Any contact between a concentrated disinfectant and the skin or mucous membranes, even of short duration, because of the potential acute effects.
- Contact between the skin/mucous membranes and the working solution, particularly when the concentrated product carries one of the following risk phrases: R40 (Limited evidence of a carcinogenic effect), R41 (Risk of serious damage to eyes), R42 (May cause sensitisation by inhalation) or R43 (May cause sensitisation by skin contact) (on this topic, see Factsheet 2, specifically Table 3 and Annex 1).
- Exposure to vapours and aerosols by inhalation.
- Inhalation of projections.

Preventive measures should always be implemented to circumvent the risks encountered at the workstation. The following list of preventive measures is designed to help with decision making in this field.

*Substitution (**S**TOP)*

Among the appropriate disinfectants for use to maintain hospital hygiene, the prevailing principle is to choose products presenting the fewest potential risks for patients and personnel. If health problems occur when using a disinfectant, the first step

to take would be to look for a product presenting fewer health risks (see Factsheet 4, Selecting safe disinfectants).

*Technical measures (S**T**OP)*

- Perform disinfection using a machine
- As far as possible, use a method which does not form aerosols
- Use technical aides (two-bucket trolleys, mops, squeezing systems, etc.)
- Dispense the concentrated disinfectant automatically, or at least use dosing aides
- Ventilate the premises
    - sufficient fresh air (according to the national regulations) should be supplied
    - or an assisted ventilation system should be installed

*Organisational aspects (ST**O**P)*

- Employ only appropriately qualified personnel, who have been informed of the risks and receive regular in-service training
- As few exterior personnel as possible should be present during surface disinfection
- If large surface areas are to be disinfected, the work zone should only be re-entered after a drying phase
- The cleaning utensils used for disinfection should be disposed of in closed containers
- Disinfectant solutions should not be in open containers, except during use
- Concentrated products should not be diluted using hot water
- Any risk of contact between the disinfectant (concentrated or dilute) and hot surfaces should be eliminated

*Personal protective measures (STO**P**)*

- Eye protection:
  During manipulation of concentrated disinfectants, if there is a risk of aerosol formation or projections, in particular during pouring or dilution, protective eye-wear should be worn (glasses with side shields or mask-type goggles).
- Hand protection:
  When using disinfectants, if contact with the hands cannot be avoided, appropriate protective gloves must be worn. To improve comfort in case of prolonged wear, cotton gloves may be worn under the protective gloves. The cotton gloves should be washed regularly. Protective gloves should be chosen depending on the type of contact and the disinfectants used.
- Skin protection:
  Skin protection, cleaning and care should be performed following the skin protection plan.
- Protective clothing:
  If workwear risks becoming soaked with the product during surface disinfection, waterproof protective clothing should be worn, e.g. a waterproof apron.
- Respiratory protection:
  If the applicable limit values for some of the ingredients in the disinfectants (e.g. aldehydes) are exceeded, appropriate respiratory protection should be used. This is a particular risk where large surface areas are disinfected using aldehyde-based products in poorly ventilated zones.

## 8. Medical surveillance

Medical surveillance of workers differs depending on the country and the applicable national regulations. Where surveillance is organised by the occupational health department, or preventive examinations are performed by the occupational physician, the worker should be informed of the potential risks to their health related to the use of surface

disinfection products, in particular by drawing their attention to the following points:

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

### 9. Monitoring preventive measures

Where national limit values for the compounds making up the disinfectants used exist, the employer must prove that the preventive measures implemented allow these limit values to be respected. To do this, measurements, comparisons with published studies describing similar situations, or validated calculation and assessment methods can be used.

Once it has been established that the activity can be performed without risk, controls can be implemented to simply verify the efficacy of the preventive measures and to ensure that no notable change to the conditions in which the task is performed has occurred (in particular, extent of work, how the chemical products are used).

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

**Factsheet 5: Surface disinfection**

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