

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

Factsheet 3: Hazards of chemical disinfectants

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.

1. Chemical disinfectants

Disinfectants are generally composed of one or more active substances which have the required disinfectant action, they may also contain diluents or solubilising agents, surfactants, foam regulators, pH regulators, sequestering agents, and sometimes perfumes. In the framework of this factsheet, we will only study the active disinfecting substances. It must be kept in mind that some additives have their own specific hazards, and these should be taken into account even if some of these substances are only present in the mixtures in small amounts. This is the case, for example, of EDTA (ethylene diamine tetracetic acid), which is found in some disinfectants and has been linked to asthma in health care workers. These hazards are pointed out in the different technical factsheets in this series. However, it is not possible to list them for every commercially available mixture. During risk assessments, any changes to the composition

of commercially available mixtures should also be taken into account.

The risks linked to the use of disinfectants depend both on the substances they contain (specific properties of each substance), and on how they are used (spraying, soaking, frequency of use, amount used, etc.), which determines the level of personnel exposure.

2. Information on the hazards linked to disinfectants

Labelling on products can be used to assess the hazards presented by the disinfectants used. For example, a study performed on disinfectants used in Germany showed the following number of labelled products:

Table 1: Labelling of disinfectants used in the health care sector in Germany – inventory performed in 2010 (see Factsheet 2).

Group of products	Number of products	Hazard symbols							
		Xi	Xn	C	O	N	F	F+	none
		Irritant	Harmful	Corrosive	Oxidising	Dangerous for the environment	Highly flammable	Extremely flammable	
Surface disinfection	478	192	18	131	5	60	21	1	124
Hand/skin disinfection	136	67	0	1	1	1	31	1	48
Instrument disinfection	182	41	22	96	0	32	2	0	23
Linen and clothing disinfection	32	17	7	18	9	2	0	0	10

The hazard symbols found indicate a broad range of hazards associated with the products. Thus, disinfectants can be:

- Corrosive (C) or irritant (Xi) – these are the most common, with effects on the skin and mucous membranes
- Harmful (Xn), with potential effects on organs
- Highly flammable (F), extremely flammable (F+) or oxidising (O), which indicates a risk of fire
- Dangerous for the environment (N), which means they should not be poured down drains.

These hazard symbols are complemented by risk phrases (R phrases) which give further details on the effect on the organism. Given their role in some occupational diseases [1], products carrying the following phrases in particular present problems: "may cause sensitisation by inhalation" (R42), "may cause sensitisation by skin contact" (R43) or "may cause sensitisation by inhalation and skin contact" (R42/43); products can also constitute a serious hazard for the eyes (R41) or be suspected carcinogens (R40).

Some specific risks relate to carcinogenic (R45 or R49), mutagenic (R46) or reprotoxic (R60 to R63) properties. These potentially very serious effects require specific preventive measures which may, in some countries, be set out in regulatory texts. As far as possible, it is essential to substitute any preparation containing a substance with one of these classifications.

NB: From 1 June 2015, the classification and labelling of mixtures of chemical products, including commercially-available disinfectants, must conform to the European CLP regulations [2]. For pure substances, this regulation has been applied since 1 December 2010. According to the terms of these regulations, dangerous substances will be ranked in hazard classes and categories, with corresponding H statements (hazard statements). A completely new set of hazard symbols will also be used.

Switzerland has adopted the provisions of the EC regulation in its regulations on chemical products.

3. Effects of disinfectants on health

In the first section of this chapter, we will list the effects of the main chemical families of substances used in disinfectants (table 2). These effects may have been observed with the substance used as a disinfectant, or in different occupational circumstances involving different quantities and levels of exposure. This list is not exhaustive but gives insight into the effects of these substances and of similar compounds. The European CLP regulations labelling system also indicates the intrinsic hazards of the pure substances. The CLP labelling for the most commonly used active substances and additives, based on a German market survey (see Factsheet 4), is presented in an annex. In the second part of this chapter, we will discuss the effects of disinfectants used in the health care sector, based on published data.

Table 2: Main groups of active substances found in disinfectants in the health care sector

Aldehydes/aldehydes releasers
Alcohols
Guanidines/Biguanides
Halogenated derivatives <ul style="list-style-type: none"> • Chlorinated derivatives • Iodated derivatives
Quaternary ammonium compounds
Peroxides
Alkylamines
Glycols and derivatives
Phenol and derivatives

3.1 Hazards by group of active substances

The hazards presented here for each group of active substances are the intrinsic hazards of the pure substances, which can be encountered in very diverse occupational sectors. They therefore

do not necessarily correspond to the exposure conditions encountered during disinfection in the health care sector with the preparations (mixtures) used.

3.1.1. Aldehydes/aldehyde releasers

3.1.1.1. Indications

Formaldehyde is a substance used as a gas or in an aqueous solution. It is bactericidal, fungicidal, tuberculocidal and virucidal. It loses some of its efficacy in the presence of proteins. This indicates that agents contained for example in sputum, pus or blood can only be eliminated after prolonged contact combined with a mechanical effect (rubbing, brushing). Because of its toxic and allergenic properties, formaldehyde is mainly used in closed systems to disinfect instruments.

Glutaraldehyde is a very effective surface disinfectant; it is bactericidal, virucidal and fungicidal. Its disadvantages are identical to those of formaldehyde.

Glyoxal is used in combination with formaldehyde and glutaraldehyde to disinfect thermostable and non-thermostable surfaces and instruments.

3.1.1.2. Hazards

Aldehydes are molecules that react with proteins in the body. They mainly have irritant (skin, eye, respiratory tract) and sensitising effects (eczema, rhinitis and asthma). Some aldehydes are absorbed through the skin.

Formaldehyde, which is either a gas or an aqueous solution, reacts with DNA in cells and can cause genotoxic and carcinogenic effects. Occupationally-induced formaldehyde-related cancers have been observed at the nasopharyngeal level, and cases of leukaemia have also been described [3]. Formaldehyde itself is found in the formulation of hospital disinfectants, as are substances capable of releasing formol either through metabolic effects in the body - such as methylene glycol - or by releasing it into the atmosphere from an aqueous solution - like with hexamethylenetetramine.

Currently, the most commonly used aldehyde is glutaraldehyde, which has been linked to numerous cases of irritation, and particularly skin and respiratory allergies.

3.1.2. Alcohols

3.1.2.1. Indications

Alcohols are adsorbed onto the cellular membrane, where they dissolve lipids, modifying the permeability of the membrane - resulting in a loss of plasma and electrolytes - and denature (i.e., modify) protein structures. Due to their lipophilic nature, they are effective within 30 seconds on vegetative bacteria and envelope viruses; and within 60 seconds on mycobacteria. However, they are ineffective against prions and bacterial spores. 2-propanol has disinfectant properties when used at 60 to 70%, ethanol when used between 70 and 80%. Alcohol-based preparations are widely used to disinfect the skin and hands and to disinfect small surfaces.

3.1.2.2. Hazards

The alcohol presenting the most risks for human health is methanol, which is not used as an active substance in disinfectants.

Like most organic solvents, alcohols can cause neurological disorders (drowsiness, dizziness, memory disorders etc.) with repeated exposure to high doses. They can also cause skin effects such as dryness of the skin and irritative dermatitis. As a general rule, the longer the carbon chain of the alcohol, the greater its irritative properties (e.g. isopropanol is a stronger irritant than ethanol).

Regular consumption of ethanol in alcoholic drinks can cause cancers and is reprotoxic. However, occupational use of ethanol does not lead to significant penetration of the substance into the body, and does not significantly affect endogenous ethanol levels in those using it. No carcinogenic or heritable effect is to be expected from straightforward occupational exposure.

3.1.3. Guanidines/Biguanides

3.1.3.1. Indications

Biguanides, such as quaternary ammonium compounds, are active substances used in products to disinfect surfaces and instruments. The substances in this group have a very limited efficacy on gram positive and negative infectious agents, including the bacteria responsible for tuberculosis.

3.1.3.2. Hazards

Biguanides have strong irritant or corrosive effects (depending on the concentration used) on the skin and mucous membranes (eye or respiratory).

Chlorhexidine is the main biguanide, used in its digluconate salt form – this is the most commonly used salt as it is the most soluble – or in its diacetate or dihydrochloride salt form. Chlorhexidine is a strongly basic compound. It is weakly or not absorbed through any route. At the usual concentrations employed, skin irritation and contact sensitisation have been reported when chlorhexidine-based disinfectants are used repeatedly, due to scouring and drying of the skin. Chlorhexidine has not been shown to have reprotoxic effects (effects on development, fertility), or carcinogenic or genotoxic effects.

3.1.4. Halogenated derivatives

3.1.4.1. Chlorinated compounds

3.1.4.1.1. Indications

Elementary chlorine is a gas which liquefies under pressure. It is used to disinfect drinking water and the water in swimming pools for leisure and care activities. A related compound, lime chloride, is used to disinfect faecal matter.

Sodium hypochlorite (bleach) is used to disinfect specific materials.

3.1.4.1.2. Hazards

Compounds releasing active chlorine such as sodium hypochlorite (bleach) are mainly irritating to the skin and mucous membranes. The dilutions used

to disinfect the skin are generally well tolerated, although some cases of allergy have been reported. At high concentrations, these compounds are highly irritant or even corrosive for the skin and mucous membranes, particularly the eyes.

3.1.4.2. Iodated compounds

3.1.4.2.1. Indications

Iodine is effective against viruses, fungi and bacteria. Aqueous solutions of iodine and PVP (polyvinylpyrrolidone) have a very wide action spectrum. They are bactericidal, virucidal, effective against MRSA (multi-resistant *Staphylococcus aureus*), tuberculocidal, and effective against a series of non-envelope viruses. They are appropriate for preoperative disinfection of the skin and hands, and for the disinfection of intact external skin and mucosa, the vagina, cervix, and urinary tract.

3.1.4.2.2. Hazards

Iodated polyvinylpyrrolidone is currently the only compound regularly used as a skin disinfectant. This substance is only weakly absorbed by oral and dermal routes. Occupational exposure has been linked to very rare allergic skin reactions and local tolerance to solutions is good (no irritation). No thyroid anomalies have been reported in personnel manipulating this disinfectant, even though in some individuals the serum iodine level may be increased.

3.1.5. Quaternary ammonium compounds

3.1.5.1. Indications

Quaternary ammonium compounds like biguanides are active substances found in products used to disinfect surfaces and instruments. The substances in this group have a very limited efficacy on gram negative agents and gram positive infectious agents, including the bacteria responsible for tuberculosis. Their use in a hospital setting should take into account that quaternary ammonium compounds lose some of their efficacy in the presence of proteins and soap.

3.1.5.2. Hazards

Quaternary ammonium compounds are irritant and sensitising substances, particularly affecting the skin. Benzalkonium chloride is the main quaternary ammonium used, it can cause digestive and neurological disorders, but it is mainly the localised effects that cause problems during disinfection processes. The pure product is corrosive, and can induce serious eye damage; even diluted at 10% it can still have an effect on the eye. The other effects are allergic effects. Benzalkonium chloride induces eczema, cases of occupational asthma (promoted by the use of spray-based application procedures) and rhinitis.

3.1.6. Peroxides

3.1.6.1. Indications

Hydrogen peroxide is a disinfectant used at a concentration of 3% to wash sores.

Peroxyacetic acid is a strong oxidant which is an effective disinfectant even at low concentrations. It is virucidal but very damaging to materials.

3.1.6.2. Hazards

Irritation of the skin and mucous membranes (eye and respiratory tract) is frequently observed in personnel when these products are used in a concentrated form, which is the case during disinfection of materials. In contrast, the dilute forms are well tolerated and are widely employed for local disinfection.

No chronic effect has yet been described with these substances.

Peroxides, as oxygen releasers, can increase the risks of fire and explosion.

3.1.7. Alkylamines

Various alkylamines are found in disinfectant preparations. They are all corrosive to the skin and are severe irritants for the eyes. Alkylamines are also responsible for allergic skin (eczema) and respiratory reactions (rhinitis, asthma).

3.1.8. Glycols and derivatives

2-phenoxyethanol appears to be the only glycol ether used as a disinfectant. The specificity of this group of substances is that it is readily absorbed through the skin. This has been confirmed for 2-phenoxyethanol, which was linked to disorders after skin contact (hand immersion). This type of exposure induced both central (headaches, euphoria, drunkenness, etc.) and peripheral (paresthesia, paresis of the hands) neurological disorders. 2-phenoxyethanol also induces dermatitis, which can be of allergic origin.

3.1.9. Phenol and derivatives

3.1.9.1. Indications

Pure phenol is effective only against the vegetative forms of bacteria and at relatively high concentrations (3 to 5%).

The disinfectant action of phenol derivatives has been improved by the addition of chlorine (chloro-cresols). These are used to disinfect surfaces, linen and clothing.

3.1.9.2. Hazards

Phenolic derivatives are toxic substances injuring various organs (liver, kidneys, nervous system).

Phenol is readily absorbed through all routes of contact, but it is rapidly eliminated in the urine. This dangerous substance causes skin lesions during acute exposure (burns) and can lead to serious eye damage if it comes into contact with the eyes. The chronic effects include digestive (vomiting, diarrhoea), neurological and skin disorders. In severe cases, the liver and kidneys can be affected.

3.1.10. Other substances

Bases and acids are used during some disinfection tasks. For the most part, these are irritant or corrosive, depending on the concentrations at which they are used. Other substances were used as disinfectants in the past, but should no longer be used (e.g. mercury derivatives).

3.2. Effects linked to disinfectants in a hospital setting

The list of disinfectants is long, as is the list of the hazards associated with them. Thus, we might expect to see a wide range of health effects among personnel using these products. However, a literature review only reveals reports of irritant or allergic effects. Skin diseases in the health care sector are most frequently mentioned in relation to working with wet skin due to the procedures used to disinfect the skin and to wearing gloves (prolonged contact with the skin).

3.2.1. Allergic respiratory diseases (rhinitis, asthma)

In France, for the 1996-1998 period, ONAP (French national observatory for occupational asthma) ranked the health care sector second for all respiratory diseases, after the bakery and pastry sector. The most common causes of occupational asthma in the medical setting are the disinfectants used, along with latex [4]. A decade later, the ONAP-RNV3P data indicated that quaternary ammonium compounds were the third cause of asthma, with disinfectants and cleaning products coming in fifth. In women, quaternary ammonium compounds are the second cause of asthma after hair products. Cleaning personnel (including hospital personnel) are the primary occupational sector affected by occupational asthma, however not all cases can be attributed to the use of disinfectants.

The following disinfectants are likely to cause asthma: formaldehyde, glutaraldehyde, quaternary ammonium compounds, chlorhexidine and alkylamines. Cases of asthma often occur in workers performing disinfection tasks where the product is applied by spraying [4].

A recent document [5] presents the results of a bibliographic study of asthma or asthma-like diseases in health care professionals triggered or revealed by the use of cleaning and disinfection products. The prevalence of work-related asthma in this population is estimated at 3%. Among the

disinfection agents the most commonly implicated are: aldehydes (glutaraldehyde) and halogenated compounds. For example, sodium hypochlorite in the presence of proteins can form chloramines, which are both respiratory irritants and sensitisers.

A more general study of cleaning and disinfection personnel (all activity sectors) confirms the high level of asthma-like respiratory diseases linked to a true allergy or to the irritant capacity of many of the substances used, and also the high frequency of these effects when products are used in a spray form [6].

3.2.2. Skin diseases

3.2.2.1. Urticaria [7]

Chlorhexidine has been linked to incidences of urticaria, although the number of cases is small despite its wide-ranging use. With a pre-existing skin sensitisation (urticaria), there is a risk of anaphylactic shock upon subsequent use, which is extremely serious.

Iodated polyvinylpyrrolidone is even more rarely suspected, and chloramine T has only been the object of one published case, describing a worker responsible for cleaning hospital baths.

Ethyl alcohol has been linked to urticaria in health care workers, and thus should be mentioned, but cases remain rare in proportion to its level of use.

3.2.2.2. Allergic eczema, irritative dermatitis [8]

Several recent articles assessed the prevalence of eczema-like dermatitis in health care personnel. The results of these are in line with previous observations. The most exposed health care professionals are the following: nurses, nurses' aides, doctors, dentists, medical auxiliaries, maintenance personnel. Along with gloves, disinfectants represent the main causes of contact dermatitis in health care personnel.

The risk of developing skin disease is high, with occupational dermatitis occurring in the health care sector at a prevalence of around 20 to 30%, which

is double that of the general population. Similar figures have been reported in several countries. For example, in Italy hospital workers are the fifth highest risk group for eczema of the hands. The problem is therefore significant, but all these diseases cannot be linked solely to disinfectants, even though disinfection procedures probably play an important role; frequent hand washing and working with wet skin appear to be the main causes of the dermatitis observed [9, 10, 11].

Several products which are used as disinfectants can cause skin irritation and/or allergies: mainly aldehydes, alcohol-based solvents, amines, etc. This makes it reasonable to implement preventive measures during their use. A study indicates that in health care personnel, on the basis of patch test results, the risk of being allergic to glutaraldehyde is eight times higher, at 17.6%, than in people not involved in this activity, where the prevalence is only 1.9%, with nurses and dental assistants being the most sensitised to glutaraldehyde.

Glyoxal is also a non-negligible allergen in the health care sector, with the highest level of sensitisation noted for dental assistants. Allergies to benzalkonium chloride are generally rare, but it does have irritant properties. Nevertheless, the rate of sensitisation is significantly higher in health care personnel, particularly nurses and dental assistants.

Vapours of some disinfectants (aldehydes) or aerosols from spray forms can lead to irritation and/or eczema of the face and other exposed areas of skin.

3.2.3. Other effects

Among the more anecdotal effects described, burns to the hands have been reported in workers using hydro-alcoholic gels followed by exposure to a source of heat [12]. Finally, it is important to point out that no study to date has shown any effect on reproduction (fertility or development) resulting from disinfection tasks performed in the health care sector.

4. Preventive measures (STOP)

All the preventive measures possible cannot be described in this factsheet. The specific measures for each task or procedure will be detailed in the corresponding factsheet, in particular factsheet 5 for surface disinfection, factsheet 6 for instrument disinfection, factsheet 7 for hand and skin disinfection. In addition, for each work situation, the preventive measures must be adapted based on the results of an overall risk assessment.

For the selection of applicable preventive measures, the European regulations set out the following hierarchy:

[I] Substitution (S)

This is the first preventive measure to consider. It consists in looking for a product and/or procedure presenting fewer health risks (see Factsheet 4 "Selecting safe disinfectants" in particular).

[II] Technical Measures (T)

The use of automated systems (particularly for instrument disinfection) and technical aides (e.g. dosing devices when diluting concentrated products) limits personnel exposure.

Localised capture devices (in the case of open disinfectant baths) or mechanical ventilation ensure that aerosols and vapours of disinfectant are extracted from the work zone.

[III] Organisational aspects (O)

It is particularly important to employ only appropriately qualified personnel, who have been informed of the risks and receive regular in-service training.

[IV] Personal protective measures (P)

When the measures from points I to III are not sufficient, it is possible to resort to complementary personal protective systems, appropriate for the existing risks: protective goggles, gloves, etc.

Finally, respiratory protection devices may be

used during some operations, when the applicable occupational exposure limits may be exceeded.

5. Medical surveillance

Medical surveillance of workers differs depending on the country and the applicable national regulations. In the context of consultations with the occupational physician or preventive occupational medical examinations, it is important to inform workers of the potential health risks linked to the use of disinfection products and to question them on any early symptoms affecting the skin or respiratory tract. Complaints linked to work and the individual pre-existing risk factors should be examined on a case-by-case basis, as should the need to implement specific protective measures for women of childbearing age.

6. 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, depending on the national regulations, air concentration measurements, comparisons with published studies describing similar situations, or validated calculation and assessment methods can be used.

Subsequent verifications will be performed as required by the national regulations and should be performed if the preventive measures are modified, or if there are any significant changes to the conditions in which the task is performed (in particular extent of work, mode of use of chemical products).

References

- [1] Arif AA, Delclos GL, Serra C. Occupational exposures and asthma among nursing professionals. *Occup Environ Med*, 2009, 66: 274-278.
- [2] Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006.
- [3] IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. Lyon, Centre international de recherche sur le cancer, 2012, 100F, pp.401-435.
- [4] Rosenberg N. Asthme professionnel dû aux désinfectants employés en milieu hospitalier. *Documents pour le médecin du travail*, 2000, 84. TR 26.
- [5] Arif AA, Delclos GL. Association between cleaning-related chemicals and work-related asthma and asthma symptoms among healthcare professionals. *Occup Environ Med*, 2012, 69 : 35-40.
- [6] Zock JP, Vizcaya D, Le Moual N. Update on asthma and cleaners. *Cur Opin Clin Immunol*, 2010, 10 (2) : 114-120.
- [7] Crépy MN. Urticaires de contact d'origine professionnelle. *Documents pour le médecin du travail*, 2007, 111. TA 76.
- [8] Crépy MN. Dermatoses professionnelles aux antiseptiques et désinfectants. *Documents pour le médecin du travail*, 2001, 85. TA 62.
- [9] Ibler KS, Jemec GB, Flyvholm MA, Diepgen TL, Jensen A, Agner T. Hand eczema: prevalence and risk factors of hand eczema in a population of 2274 healthcare workers. *Contact Dermatitis*. 2012a, 67 (4): 200-207.
- [10] Ibler KS, Jernec GBE, Agner T. Exposure related to hand eczema: a study of healthcare workers. *Contact Dermatitis*, 2012b, 66 :247-253.
- [11] Machovcová A, Fenclová Z, Peclová D. Occupational skin diseases in Czech healthcare workers from 1997 to 2009. *Int Arch Occup Environ Health*, 2013 Apr; 86(3): 289-294. (à paraître)
- [12] O'Leary FM, Price GJ. Alcohol hand gel--a potential fire hazard. *J Plast Reconstr Aesthet Surg*. 2011, 64(1) :131-132.

Annex: Active substances and main additives: classification¹⁾ according to the CLP regulations

Substances	CAS number	CLP classification	Pre-existing classification based on the European directive ³⁾
Aldehydes / aldehyde releasers			
Formaldehyde...%	50-00-0	<p>Acute toxicity (by inhalation), category 2; H330 Acute toxicity (by oral route), category 3; H301 Acute toxicity (through skin contact), category 3; H311 Skin corrosion, category 1B; H314 Specific target organ toxicity (single exposure), category 3; H335 Carcinogenic, category 2; H351 Skin sensitisation, category 1; H317 NB: According to the 6th Adaptation to technical progress to CLP, as of 5 June 2014 the classification has changed as follows: Acute toxicity (by inhalation), category 3; H331 Carcinogenic, category 1B; H350 Mutagenic, category 2; H341</p>	<p>T; R23/24/25 C; R34 Carc.Cat.3; R40 R43 NB: According to the 6th Adaptation to technical progress to CLP, as of 5 June 2014 the classification has changed as follows: Carc.Cat.2; R45 Muta.Cat.3; R68</p>
Glyoxal	107-22-2	<p>Mutagenic - affecting germ cells, category 2; H341 Acute toxicity (by inhalation), category 3; H331 Eye irritation, category 2; H319 Skin irritation, category 2; H315 Skin sensitisation, category 1; H317</p>	<p>Muta.Cat.3; R68 Xn; R20 Xi; R36/38 R43</p>

Substances	CAS number	CLP classification	Pre-existing classification based on the European directive ³⁾
Glutaraldehyde	111-30-8	Acute toxicity (by inhalation), category 3; H331 Acute toxicity (by oral route), category 3; H301 Skin corrosion, category 1B; H314 Serious eye damage, category 1; H318 Respiratory sensitisation, category 1; H334 Skin sensitisation, category 1; H317 Specific target organ toxicity (single exposure), category 3; H335 Hazard for aquatic life - acute hazard, category 1; H400	T; R23/25 C; R34 R42/43 N; R50
(Ethylenedioxy)dimethanol	3586-55-8	Acute toxicity (by oral route), category 4; H302 Skin irritation, category 2; H315 Eye irritation, category 2; H319 Specific target organ toxicity (single exposure), category 3; H335	Xn; R 22 R 36/37/38
Alcohols			
Ethanol	64-17-5	Flammable liquids, category 2; H225	F; R11
2-Propanol	67-63-0	Flammable liquids, category 2; H225 Eye irritation, category 2; H319 Specific target organ toxicity (single exposure), category 3; H336	F; R11 Xi; R36 R67
1-Propanol	71-23-8	Flammable liquids, category 2; H225 Serious eye damage, category 1; H318 Specific target organ toxicity (single exposure), category 3; H336	F; R11 Xi; R41 R67
Benzyl alcohol	100-51-6	Acute toxicity (by inhalation), category 4; H332 Acute toxicity (by oral route), category 4; H302	Xn; R20/22

Substances	CAS number	CLP classification	Pre-existing classification based on the European directive ³⁾
Ethanolamine	141-43-5	Acute toxicity (by oral route), category 4; H302 Acute toxicity (through skin contact), category 4; H312 Acute toxicity (by inhalation), category 4; H332 Skin corrosion, category 1B; H314 Specific target organ toxicity (single exposure), category 3; H335	Xn; R20/21/22 C; R34
Guanidines/Biguanides			
Chlorhexidine ⁴⁾	55-56-1	Serious eye damage, category 1; H318 Hazard for aquatic life - chronic hazard, category 2; H411	Xi; R 41 N; R 51/53
Polyhexamethylenebiguanide hydrochloride ⁵⁾	27083-27-8	Serious eye damage, category 1; H318 Hazard for aquatic life - acute hazard, category 1; H400 Hazard for aquatic life - chronic hazard, category 1; H410 Skin corrosion, category 2; H315 Skin sensitisation, category 1; H317	Xn; R22 Xi; R38, R41 Xi; R43 N; R50/53
Guanidine, N,N'''-1,3-propanediylbis-, N-coco alkyl derivatives, diacetates / Cocospropylenediamine guanidium acetate ⁶⁾	85681-60-3	Not indicated	R10 Xn; R22 C; R34 N; R50
Guanidine, N,N'''-1,3-propanediylbis-, N-coco alkyl derivatives ⁷⁾	98246-84-5	Not indicated	Xn; R22 C; 34 N; 50
Halogenated derivatives			
Sodium hypochlorite (bleach)	7681-52-9	Skin corrosion, category 1B; H314 Hazard for aquatic life - acute hazard, category 1; H400	C; R34 R31 N; R50

Substances	CAS number	CLP classification	Pre-existing classification based on the European directive ³⁾
Povidone iodine / PVP iodine ⁸⁾	25655-41-8	Skin corrosion, category 2; H315 Serious eye damage, category 1; H318 Hazard for aquatic life - chronic hazard, category 2; H411	Xi; R36 N; R51/53
Quaternary ammonium compounds			
Mecetronium ethylsulfate / Ethylhexadecyldimethylammonium ethylsulfate ⁹⁾	3006-10-8	Not indicated	R22 C; R34 N; R50
Bisoctyl dimethyl ammonium chloride / Dimethyldioctylammonium chloride ¹⁰⁾	5538-94-3	Acute toxicity (by oral route), category 4; H302 Skin corrosion, category 1B; H314 Hazard for aquatic life - acute hazard, category 1; H400	Xn; R22 C; R34 N; R50
Didecyl dimethyl ammonium chloride	7173-51-5	Acute toxicity (by oral route), category 4; (minimal classification); H302 Skin corrosion, category 1B; H314	Xn; R22 C; R34
Benzalkonium chloride	63449-41-2	Acute toxicity (by oral route), category 4; H302 Acute toxicity (through skin contact), category 4; H312 Skin corrosion, category 1B; H314 Hazard for aquatic life - acute hazard, category 1; H400	Xn; R21/22 C; R34 N; R50
Alkyl benzyl dimethylammonium chloride	68391-01-5	Acute toxicity (by oral route), category 4; H302 Acute toxicity (through skin contact), category 4; H312 Skin corrosion, category 1B; H314 Hazard for aquatic life - acute hazard, category 1; H400	Xn; R21/22 C; R34 N; R50
Alkyl dimethyl benzyl ammonium chloride ¹¹⁾	68424-85-1	Acute toxicity (by oral route), category 4; H302 Skin corrosion, category 1B; H314 Hazard for aquatic life - acute hazard, category 1; H400	C; R34 Xn; R22 N; R50

Substances	CAS number	CLP classification	Pre-existing classification based on the European directive ³⁾
Benzyl-C12-14-alkyldimethyl, chlorides ¹²⁾	85409-22-9	Not indicated	N; R50 C; R34 Xn; R 22
C12-14-Alkyldimethyl(ethylbenzyl)ammonium chloride / N-Alkyl dimethyl ethylbenzyl ammonium chloride ¹¹⁾	85409-23-0	Acute toxicity (by oral route), category 4; H302 Skin corrosion, category 1B; H314 Hazard for aquatic life - acute hazard, category 1; H400	Xn; R22 C; R34 N; R50
Didecylmethylpoly(oxethyl) Ammonium Propionate / N,N-Didecyl-N-methylpoly(oxymethyl)ammonium propionate ¹³⁾	94667-33-1	Not indicated	C; R34 Xn; R22 N; R50
1-Decanaminium, N-decyl-N-(2-hydroxyethyl)-N-methyl-propanoate (salt) ¹⁴⁾	107879-22-1	Not indicated	Xn; R22 C; R34 N; R50
Peroxides			
Peroxyacetic acid / Peracetic acid	79-21-0	Flammable liquids, category 3; H226 Organic peroxides, type D; H242 Acute toxicity (by oral route), category 4; H302 Acute toxicity (through skin contact), category 4; H312 Acute toxicity (by inhalation), category 4; H332 Skin corrosion, category 1A; H314 Specific target organ toxicity (single exposure), category 3; H335 Hazard for aquatic life - acute hazard, category 1; H400	R10 O; R7 Xn; R20/21/22 C; R35 N; R50

Substances	CAS number	CLP classification	Pre-existing classification based on the European directive ³⁾
Hydrogen peroxide	7722-84-1	Oxidising liquids, category 1; H271 Acute toxicity (by oral route), category 4; H302 Acute toxicity (by inhalation), category 4; H332 Skin corrosion, category 1A; H314 Serious eye damage, category 1; H318 Specific target organ toxicity (single exposure), category 3; H335	R5 O; R8 C; R35 Xn; R20/22
Sodium percarbonate	15630-89-4	Oxidising solid materials, category 2; H272 Acute toxicity (by oral route), category 4; H302 Serious eye damage, category 1; H318	O; R8 Xn; R22 R41
Potassium peroxymonosulphate / Potassium monopersulphate	70693-62-8	Acute toxicity (by oral route), category 4; H302 Skin corrosion, category 1B; H314	Xn; R22 C; R34 R52
Alkylamines			
N-(3-Aminopropyl)-N-dodecylpropane-1,3-diamine ¹⁵⁾	2372-82-9	Not indicated	C; R35 Xn; R48/22 N; R50
N-dodecyl-1,3-diamine	5538-95-4	Acute toxicity (by oral route), category 4; H302 Skin corrosion, category 1A; H314 Hazard for aquatic life - acute hazard, category 1; H400	C; R35 R22 N; R50
Glycols and derivatives			
Ethanediol	107-21-1	Acute toxicity (by oral route), category 4; H302	Xn; R22
1,4-Butanediol	110-63-4	Acute toxicity (by oral route), category 3; H301	Xn; R22

Substances	CAS number	CLP classification	Pre-existing classification based on the European directive ³⁾
Butyldiglycol / 2-(2-Butoxyethoxy)ethanol	112-34-5	Eye irritation, category 2; H319	Xi; R36
2-Phenoxyethanol	122-99-6	Acute toxicity (by oral route), category 4; H302 Eye irritation, category 2; H319	Xn; R22 Xi; R36
Phenol and derivatives			
4-Chloro-3-methylphenol	59-50-7	Acute toxicity (through skin contact), category 4; H312 Acute toxicity (by oral route), category 4; H302 Serious eye damage, category 1; H318 Skin sensitisation, category 1; H317 Hazard for aquatic life - acute hazard, category 1; H400	Xn; R21/22 Xi; R41 R43 N; R50
2-Phenylphenol / Biphenyl-2-ol	90-43-7	Specific target organ toxicity (single exposure), category 3; H335 Skin irritation, category 2; H315 Eye irritation, category 2; H319 Hazard for aquatic life - acute hazard, category 1; H400	Xi; R36/37/38 N; R50
Phenol	108-95-2	Acute toxicity (by inhalation), category 3; H331 Acute toxicity (by oral route), category 3; H301 Acute toxicity (through skin contact), category 3; H311 Skin corrosion, category 1B; H314 Mutagenicity on germ cells, category 2; H341 Specific target organ toxicity (single exposure), category 2; H373	Muta.Cat.3; R68 T; R23/24/25 Xn; R48/20/21/22 C; R34
Clorofene / 2-Benzyl-4-chlorophenol	120-32-1	Acute toxicity (by oral route), category 4; H302 Skin irritation, category 2; H315 Serious eye damage, category 1; H318 Specific target organ toxicity (single exposure), category 3; H335 Hazard for aquatic life - acute hazard, category 1; H400	Xn; R22 R37/38 R41 N; R50/53

Substances	CAS number	CLP classification	Pre-existing classification based on the European directive ³⁾
Bases			
Sodium carbonate	497-19-8	Eye irritation, category 2; H319	Xi; R36
Potassium hydroxide (caustic potash)	1310-58-3	Skin corrosion, category 1A; H314 Acute toxicity (by oral route), category 4; H302 Corrosive to metals, category 1; H290	Xn; R22 C; R35
Sodium hydroxide (caustic soda)	1310-73-2	Skin corrosion, category 1A; H314 Corrosive to metals, category 1; H290	C; R35
Sodium silicate	1344-09-8	Acute toxicity (by oral route), category 4; H302 Skin irritation, category 2; H315 Serious eye damage, category 1; H318 Specific target organ toxicity (single exposure), category 3; H335	Xi; R36/37/38
Acids			
Acetic acid	64-19-7	Flammable liquids, category 3; H226 Skin corrosion, category 1A; H314	R10 C; R35
Citric acid (anhydrous and monohydrated)	77-92-9 and 5949-29-1	Serious eye damage, category 1; H318	Xi; R41
Maleic acid	110-16-7	Acute toxicity (by oral route), category 4; H302 Skin irritation, category 2; H315 Eye irritation, category 2; H319 Specific target organ toxicity (single exposure), category 3; H335 Skin sensitisation, category 1; H317	Xn; R22 Xi; R36/37/38 R43

Substances	CAS number	CLP classification	Pre-existing classification based on the European directive ³⁾
Main additives			
Ethylene diamine tetracetic acid, tetrasodium salt	64-02-8	Acute toxicity (by oral route), category 4; H302 Serious eye damage, category 1; H318 Acute toxicity (by inhalation), category 4; H332	Xn; R22 Xi; R41
Piperazine	110-85-0	Skin corrosion, category 1B; H314 Respiratory sensitisation, category 1; H334 Skin sensitisation, category 1; H317 May damage fertility. May damage the foetus, category 2; H361fd	Repr.Cat.3; R62, R63 C; R34 R42/43
Sodium-2-ethylhexylsulphate ¹⁵⁾	126-92-1	Not indicated	Xi; R38, R41
Chloramine T trihydrate	127-65-1	Acute toxicity (by oral route), category 4; H302 Skin corrosion, category 1B; H314 Respiratory sensitisation, category 1; H334	Xn; R22 R31 C; R34 R42
Nitriloacetic acid	139-13-9	Carcinogenic, category 2; H351 Acute toxicity (by oral route), category 4; H302 Eye irritation, category 2; H319	Carc.Cat.3; R40 Xn; R22 Xi; R36
Potassium carbonate	584-08-7	Skin irritation, category 2; H315 Eye irritation, category 2; H319 Specific target organ toxicity (single exposure), category 3; H335	Xi; R36/37/38
Nitrilotriacetic acid, trisodium salt	5064-31-3	Carcinogenic, category 2; H351 Acute toxicity (by oral route), category 4; H302 Eye irritation, category 2; H319	Carc.Cat.3; R40 Xn; R22 Xi; R36

Substances	CAS number	CLP classification	Pre-existing classification based on the European directive ³⁾
Sodium nitrite	7632-00-0	Oxidising solid materials, category 3; H272 Acute toxicity (by oral route), category 3; H301 Hazard for aquatic life - acute hazard, category 1; H400	O; R8 T; R25 N; R50
Polyethyleneglycol 300 monodecylether ¹⁶⁾	26183-52-8	Not indicated	Xi; R 41
Glycolic acid ethoxylate octyl ether ¹⁷⁾	53563-70-5	Not indicated	Xi; R38, R41
Cocamidopropyl Betaine ¹⁸⁾	61789-40-0	Not indicated	Xi; R36 R52
Isodecyl alcohol ethoxylated ¹³⁾	61827-42-7	Not indicated	Xi; R41 Xn; R22
Alcohols, C12-15, ethoxylated ¹⁹⁾	68131-39-5	Serious eye damage, category 1; H318 Hazard for aquatic life - acute hazard, category 1; H400	Xi; R41 N; R50
Benzenesulfonic acid, C10-13 alkylated derivatives, sodium salt ¹⁹⁾	68411-30-3	Acute toxicity (by oral route), category 4; H302 Skin irritation, category 2; H315 Serious eye damage, category 1; H318	Xi; R38, R41 Xn; R22
Alcohols, C9-11, ethoxylated / Polyethyleneglycol alkyl-(C9-C11)-ether ²⁰⁾	68439-46-3	Skin irritation, category 2; H315 Serious eye damage, category 1; H318	Xi; R 38, 41
Alcohols, C12-14, ethoxylated ¹⁹⁾	68439-50-9	Serious eye damage, category 1; H318 Hazard for aquatic life - acute hazard, category 1; H400	Xi; R41 N; R50
Branched tridecylalcohol, ethoxylated ¹⁵⁾	69011-36-5	Not indicated	Xi; R41 Xn; R22
Alcohols, C10-16, ethoxylated propoxylated ²¹⁾	69227-22-1	Not indicated	Xn; R22 R41

Substances	CAS number	CLP classification	Pre-existing classification based on the European directive ³⁾
Sulfonic acids, C13-17-sec-alkanes, sodium salts ²²⁾	85711-69-9	Not indicated	Xi; R38, R41
C9-C16 alcohols, ethoxylated ⁶⁾	97043-91-9	Not indicated	Xn; R22 Xi; R41
Lauryl glucoside / Alkylpolyglycoside ²³⁾	110615-47-9	Not indicated	Xi; R38, R41

1. The data on classification are derived from the GESTIS database published by the Institute for Occupational Safety and Health of the German accident insurance funds (Institut für Arbeitsschutz der Deutschen Gesetzlichen Unfallversicherung; website HYPERLINK "<http://www.dguv.de/ifa/de/gestis/stoffdb/index.jsp>"; Search performed 05/11/2012). For the substances not present in the database, the information was sought on the Internet. The corresponding sources of information are indicated in the following notes.
2. EC regulation No. 1272/2008 of the European parliament and Counsel on 16 December 2008 relating to the classification, labelling and packaging of substances and mixtures, modifying and abrogating directives 67/548/CEE and 1999/45/CE and modifying EC regulation No. 1907/2006.
3. Classification according to the EC regulations, annex VI, Table 3.2.
4. "Chlorhexidin (Labor)" factsheet, system for information on chemical products published by the BG RCI (German statutory accident insurance fund Raw materials and chemical industry), www.gischem.de
5. MSDS for Unigloves Desinfektionsmittel für Absauganlagen (disinfection products for aspiration systems) updated 7/2/2011, manufacturer/supplier: Unigloves Arzt- und Klinikbedarf Handelsgesellschaft mbH; www.unigloves.de/deutsch/sidat/sidatpdf/absaug_anlagesi.pdf
6. MSDS for DC Instrumentenbad NF (bath for instruments) updated 15/4/2009, manufacturer/supplier: DC Dental Central; http://dentalcentral.de/datasheet/.../DC_Instrumentenbad_NF_SDB__D.pdf
7. MSDS for Apesin Rapid 5LD of 20/10/2009, manufacturer/supplier: Tana Chemie GmbH; http://www.tana.de/sites/default/files/datenblaetter/apesin_rapid_5_l_d_1104603_de.pdf
8. MSDS for Polyvidon-Iod updated 05/07/2012, manufacturer/supplier: Caesar & Loretz GmbH, www.caelo.de/getfile.html?type=sdb&num=2546
9. MSDS for Spirodec Plus updated 05/03/2008, manufacturer/supplier: Intersprio GmbH, www.gfd-katalog.com/master/media/media/33/338433_SICHERHEITSDATENBLATT.PDF?MediandoWEB_gfd_hobrand=b2a5ffd1261d23a5ae71ec14f217e872
10. MSDS for Gigasept Med forte updated 21/4/2007, manufacturer/supplier: Schülke & Mayr GmbH, http://www.schuelke.com/download/pdf/cde_lde_gigasept_med_forte_sds.PDF and for product C066-K10 hebro@oilsplit of 28/4/2012, manufacturer/supplier: hebro chemie GmbH, www.hebro-chemie.de/sdb/DE/DE/540057257.DE.pdf
11. MSDS for Beko Desinfektionsreiniger Artikelnummer: 299 36 1000 updated 19/4/2011, manufacturer/supplier: beko GmbH, www.beko-group.com/uploads/tx_bekoproducts/SDB_Desinfektionsreiniger_DE.pdf
12. MSDS for Dürr System-Hygiene Orotol® Plus Sauganlagen-Desinfektion (disinfection of aspiration systems) updated 6/7/2009, manufacturer/supplier: orochemie GmbH + Co.KG, www.duerrdental.de
13. MSDS for oro® Hygienesystem B 15 Wischdesinfektion (disinfection by wiping) updated 12/1/2010, manufacturer/supplier: orochemie GmbH + Co.KG, www.orochemie.de/de/download/datenblatt_b15.pdf
14. MSDS for DC Abformdesinfektion, 018052 +018053 updated 26/4/2006, manufacturer/supplier: Dental Central Großhandels-GmbH, http://dental-central.de/datasheet/sdb/DC_Abformdesinfektion_SDB__D.pdf
15. MSDS for oro® Hygienesystem B 25 Wischdesinfektion (disinfection by wiping) updated 12/1/2010, manufacturer/supplier: orochemie GmbH + Co.KG, www.orochemie.de/de/download/datenblatt_b25.pdf
16. MSDS for Dürr System-Hygiene FD 370 cleaner Praxisreiniger (cleaning product for dental surgeries) updated 29/5/2009, manufacturer/supplier: orochemie GmbH + Co.KG, www.duerrdental.de
17. MSDS for AlproJet-DD updated 16/4/2007, manufacturer/supplier: ALPRO MEDICAL GmbH, www.kleindental.de/fileadmin/templates/pdf/.../AlproJetDD.pdf
18. MSDS for Primasept Med updated 23/01/2008, manufacturer/supplier: Schülke & Mayr GmbH, http://www.schuelke.com/download/pdf/cde_lde_primaseptmed_sds.PDF

19. Classification established by the ECHA - European Chemicals Agency,
<http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database>
20. MSDS for graffitiCRACK soft Reinigungs-Zusatz updated 21/4/2009,
manufacturer/supplier: Zufor GmbH,
<http://www.zufor.de/>
21. MSDS for Zecken-Frey 25 ml updated 15/05/07, manufacturer/supplier: Hagopur AG,
http://www.zehner-agrar.de/sicherheitsdatenblaetter/sdb/Maerkte_570.html
22. MSDS for MELLERUD Acryl Reiniger und Pflege 0.5 l updated 10/09/2009,
manufacturer/supplier: MELLERUD CHEMIE GmbH,
www.i-m.de/gefahrstoffe/254427.pdf
23. MSDS for Excipial Clean updated 29/05/2009, manufacturer/supplier: Spirig Pharma AG,
http://www.spirig.at/upload/downloads///Sicherheitsdatenblatt_Excipial_Clean.pdf

Wording of the H statements used:

- H225: Highly flammable liquid and vapour.
- H226: Flammable liquid and vapour.
- H242: Heating may cause a fire.
- H271: May cause fire or explosion; strong oxidiser.
- H272: May intensify fire; oxidiser.
- H290: May be corrosive to metals.
- H301: Toxic if swallowed.
- H302: Harmful if swallowed.
- H311: Toxic in contact with skin.
- H312: Harmful in contact with skin.
- H314: Causes severe skin burns and eye damage.
- H315: Causes skin irritation.
- H317: May cause an allergic skin reaction.
- H318: Causes serious eye damage.
- H319: Causes serious eye irritation.
- H330: Fatal if inhaled.
- H331: Toxic if inhaled.
- H332: Harmful if inhaled.
- H334: May cause allergy or asthma symptoms or breathing difficulties if inhaled.
- H335: May cause respiratory irritation.
- H336: May cause drowsiness or dizziness.
- H341: Suspected of causing genetic defects.
- H351: Suspected of causing cancer.
- H361fd: Suspected of damaging fertility. Suspected of damaging the unborn child.
- H373: May cause damage to organs through prolonged or repeated exposure.
- H400: Very toxic to aquatic life.
- H410: Very toxic to aquatic life with long lasting effects.
- H411: Toxic to aquatic life with long lasting effects.

Wording of the R-Phrases used:

- R5: Heating may cause an explosion
- R7: May cause fire
- R8: Contact with combustible material may cause fire
- R10: Flammable
- R11: Highly flammable
- R20: Harmful by inhalation
- R22: Harmful if swallowed
- R25: Toxic if swallowed
- R31: Contact with acids liberates toxic gas
- R34: Causes burns
- R35: Causes severe burns
- R36: Irritating to eyes
- R38: Irritating to skin
- R40: Limited evidence of a carcinogenic effect
- R41: Risk of serious damage to eyes
- R42: May cause sensitisation by inhalation
- R43: May cause sensitisation by skin contact
- R45: May cause cancer
- R50: Very toxic to aquatic organisms
- R52: Harmful to aquatic organisms
- R62: Possible risk of impaired fertility
- R63: Possible risk of harm to the unborn child
- R67: Vapours may cause drowsiness and dizziness
- R68: Possible risk of irreversible effects

Combinations

- R20/22: Harmful by inhalation and if swallowed
- R20/21/22: Harmful by inhalation, in contact with skin and if swallowed
- R21/22: Harmful in contact with skin and if swallowed
- R23/25: Toxic by inhalation and if swallowed
- R23/24/25: Toxic by inhalation, in contact with skin and if swallowed
- R36/38: Irritating to eyes and skin
- R36/37/38: Irritating to eyes, respiratory system and skin

- R37/38: Irritating to respiratory system and skin
- R42/43: May cause sensitization by inhalation and skin contacts
- R48/22: Harmful: danger of serious damage to health by prolonged exposure if swallowed
- R48/20/21/22: Harmful: danger of serious damage to health by prolonged exposure through inhalation, in contact with skin and if swallowed
- R50/53: Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment
- R51/53: Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment

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

Factsheet 3: Hazards of chemical disinfectants

12/2014

Authors

Prof. Dr.-Ing. Udo Eickmann
Berufsgenossenschaft für Gesundheitsdienst und
Wohlfahrtspflege (BGW), Hamburg (D)



Martine Bloch
Institut national de recherche et de sécurité (INRS)
Paris (F)



Dr. med. Michel Falcy
Institut national de recherche et de sécurité (INRS)
Paris (F)

Dr. rer. nat. Gabriele Halsen
Berufsgenossenschaft für Gesundheitsdienst und
Wohlfahrtspflege (BGW), Hamburg (D)



Dr. med. Brigitte Merz
Schweizerische Unfallversicherungsanstalt (Suva),
Lucerne (CH)

Published by

ISSA International Section on Prevention of
Occupational Risks in Health Services
Pappelallee 33/35/37
D 22089 Hamburg
Germany



Publication number

ISBN 978-92-843-6191-5

Design

Susanne Stamer
Berufsgenossenschaft für Gesundheitsdienst und
Wohlfahrtspflege (BGW), Hamburg (D)