

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

## Factsheet 4: Selecting safe 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.



INTERNATIONAL SOCIAL SECURITY ASSOCIATION

Section on *Prevention of Occupational Risks in Health Services*

## 1. Introduction

A good disinfectant should not only provide the necessary efficacy at an attractive price, but should also be risk-free for those using it. As part of the regulations relating to risk assessment, the employer must identify the risks associated with an activity and the products used. On the basis of this information, they should determine the appropriate preventive measures [1]. To analyse whether substitution is possible, the decider must be aware of the products available on the market, from which the most appropriate will be chosen. However, in many countries, hundreds of disinfectants are available, and for the general user, it is practically impossible to have an overview of all the products available on the market [2].

In the present factsheet we will present a method to help select a satisfactory disinfectant (from the point of view of occupational risk prevention). This method meets the requirements of European law relating to dangerous products, which requires any risk to workers to be limited as far as possible. It is based on freely-accessible data, such as the labelling and classification of products, the material safety datasheets and similar product information.

Potential product substitution is examined based solely on these data, even if some of the working disinfectant solutions are not required to carry the same labels as their concentrated counterpart.

When choosing a disinfectant, it is important to consider that vapour, aerosols etc. may be emitted not only due to the product characteristics but also to the way it is used.

## 2. Designing an assessment scheme to identify "safe" disinfectants

The approach is based on how disinfection products are labelled, which includes:

- one or more hazard symbols **and**
- risk phrases (R phrases).











A chemical product which does not present any

dangerous properties, or which presents only a low level of danger, will not be labelled with a hazard symbol. The more dangerous properties a product has, the more hazard symbols or R phrases it will carry. In addition, there is a grading system for dangerous properties: corrosive products are more dangerous than irritants, and toxic products are more dangerous than harmful products. We can therefore establish a hazard level to which products can be assigned based on the hazard symbols present on their labels (Table 2).

### 2.1 Assessment based on pre-existing labelling and classification rules

As preparations, disinfectants are currently almost exclusively labelled according to the classification and labelling system defined by the "old" European classification and labelling directives [3,4,5] (Table 1).

**Table 1:** Main labelling elements for hazardous substances found on disinfectant labels (valid until June 2015)

Hazard symbols			Hazard symbols		
Pictogram	Indication of danger	Meaning	Pictogram	Indication of danger	Meaning
	Xn	Harmful		F+	Extremely flammable
	Xi	Irritant		T	Toxic
	C	Corrosive		T+	Very toxic
	O	Oxidising		N	Dangerous for the environment
	F	Highly flammable		E	Explosive
<b>Risk phrases - R phrases</b>			<b>Safety advice phrases - S phrases</b>		
<p><b>R phrases</b> indicate specific risks. They are numbered and standardised. For disinfectants, the following phrases are commonly encountered:</p>			<p><b>S phrases</b> are advice relating to the safety measures to be applied. Like R phrases, they are numbered and standardised; examples:</p>		
<b>R12:</b> Extremely flammable			<b>S37:</b> Wear suitable gloves		
<b>R34:</b> Causes burns			<b>S39:</b> Wear eye/face protection		
<b>R38:</b> Irritating to skin			<b>S51:</b> Use only in well-ventilated areas		
<b>R40:</b> Suspected carcinogen					
<b>R41:</b> Risk of serious damage to eyes					
<b>R42:</b> May cause sensitisation by inhalation					
<b>R43:</b> May cause sensitisation by skin contact					
<b>R42/43:</b> May cause sensitisation by inhalation and skin contact					

This system will remain valid until June 2015, which marks the end of the transition period for chemical products, and thus for disinfectants. Ta-

ble 2 is therefore based on the information available to date on the hazards linked to disinfectants.

**Table 2:** Determining hazard levels for disinfectants based on hazard symbols present on labels

Determining the hazard level	
Hazard level	Hazard symbols
<b>A</b>	None
<b>B</b>	Xi; Xn; F; N
<b>C</b>	C; F+; Xi and F; Xi and F+; Xi and N Xi and O; Xi and Xn Xn and F; Xn and N
<b>D</b>	C and N; C and O; C and O and N T; T and N; Xi and C; Xi and C and O Xi and O and N; Xn and C

Level A (lowest hazard level) includes disinfectants for which the label carries no hazard symbols. Level B corresponds to products carrying only one of the hazard symbols Xi, Xn, F or N. If, instead of symbol Xi (irritant), symbol C (corrosive) is present, the product will be classed in level C; this is also the case if F+ (extremely flammable) replaces F (highly flammable), or if two hazards are indicated: Xi and F or F+, for example, or Xi and Xn, or Xi and O (oxidising). Level D groups together all the other symbol combinations, e.g. symbols C and N (dangerous for the environment), or Xi and O and N.

The combinations of hazard symbols mentioned for levels C and D are based on a market study performed in Germany. In other countries, products may carry combinations other than those described here.

Another particularly important criterion for classification is the presence of some R phrases indicating particularly severe risks, such as:

- R40 Suspected carcinogen
- R41 Risk of serious damage to the eyes

- R42 May cause sensitisation by inhalation
- R43 May cause sensitisation by skin contact
- R42/43 May cause sensitisation by inhalation and skin contact

Phrase R40 is often found on products containing formaldehyde, and phrase R41 on alcohol-based disinfectants where 1-propanol is the active substance. Phrases R42 and R43 can indicate the presence of aldehydes in particular.

None of the currently available products carry warnings of even more worrying properties, such as R45 (may cause cancer), R46 (may cause heritable genetic damage), etc. However, vigilance is recommended, and all R phrases indicating risks linked to the use of products should be duly noted.

The choice of disinfectants can be refined by examining both the hazard levels described above and the presence of specific R phrases. Thus, we define a system of hazard levels from A to D, "with/without R4x" (where R4x refers to one of the phrases between R40 and R43). Some examples of how this can be used for various disinfection applications will be presented below.

Only disinfectants of similar efficacy can be compared. It is therefore important to consider the active substance or group of active substances contained in any disinfectant. Thus, aldehydes do not present the same risks as alcohols or peroxides, but they also have distinct effects on microorganisms. When looking for a substitute product, as far as possible, it is important to compare products with the same action spectrum (as stated in point 3.1). When different groups of active substances can be used, those presenting the fewest hazards should be chosen. Similarly, within a group, the active ingredient presenting the fewest hazards will be selected.

## 2.2 Assessment of disinfectants from June 2015

From June 2015 all disinfectants must be classed and labelled according to the CLP regulations [6]. Like the current regulations, these regulations are also standardised and in some cases allow more precise differentiation between products. It will thus be possible to identify compounds which are corrosive for metals, or toxic for specific organs. It must be noted that the threshold - generally concentration limits for the substances in the product - from which a mixture will be classed as harmful, irritant or corrosive, toxic or highly toxic is not a simple transposition from the old to the new system. As of today, it is therefore not possible to say what hazard symbols and classifications will be used by manufacturers for each type of disinfectant.

Thus, until 2015 it will not be possible to establish a “new” precise systematic approach assessing the risks associated with using disinfectants.

## 3. Comparative study of a group of disinfectants

For a number of years in Germany, VAH (*Verbund*

*für angewandte Hygiene*, Association for applied hygiene) has assessed and published a list of disinfectants. This list, which is limited to procedures involving disinfection of surfaces, instruments, hands/skin and linen and clothing, is regularly updated [7]. It is a list of products which have been tested according to the standardised methods developed by the DGHM (*Deutsche Gesellschaft für Hygiene und Mikrobiologie*, German society for hygiene and microbiology). This data has been used, along with information relating to product composition, labelling and classification. In 2010, a total of 795 datasets were gathered relating to 478 surface disinfection products, 136 skin and hand disinfection products, and 182 instrument disinfection products. **Table 3** presents an overview of the hazard symbols used for these products in line with the current European regulations relating to hazardous substances, this is a first indication of the hazards linked to these products.

**Table 3:** Hazard symbols present on the disinfectants for which the data has been exploited

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

From this data it becomes obvious that the majority of disinfectants carry one or more hazard symbols, although none are labelled toxic or highly toxic. 35.5% of skin and hand disinfection products carry no symbol, 67 are classed as irritants and 32 are highly or extremely flammable. This labelling/classification differs significantly from that found on products for surface and instrument disinfection. To assess the true risks, however, it is important to consider how the products are used: skin and hand disinfection involves direct application of an undiluted product to the skin, while surface and instrument disinfection, in most cases, involves (ready-to-use) diluted solutions, and personal pro-

tective measures (such as gloves) can be used.

The data can be used to analyse the products by risk phrase (R phrase). Beyond the risk of fire and the environmental risks, it is important to consider irreversible risks, for example those linked to skin and respiratory pathway sensitisation (R42, R43, R42/43) or to suspected carcinogenic properties (R40). **Table 4** indicates the distribution of products based on the risk phrases they carry. Once again, the surface and instrument disinfection products include the most sensitising products: 12.9% for surfaces and 24.1% for instruments, against 0% for skin and hand disinfectants.

**Table 4:** Product distribution based on risk phrases

Group of products	Number of products	R phrases			
		R40	R42	R43	R42/43
Surface disinfection	478	17	5	24	33
Hand/skin disinfection	136	0	0	0	0
Instrument disinfection	182	10	7	9	28

### 3.1 Surface disinfectants

The data available for the 478 surface disinfectants, when analysed according to the criteria described in section 2, provided the following results for the hazard levels and groups of active substances (**tables 5 to 9**):

**Table 5:** Surface disinfectants: distribution by hazard levels

Hazard level	Total number	Number without R4x	Number with R4x
A	124	124	0
B	195	81	114
C	114	66	48
D	45	32	13
<b>Total</b>	<b>478</b>	<b>303</b>	<b>175</b>

Among the surface disinfectants available on the market, examples in each of the four hazard levels from A to D are found. None of the 124 products ranked at hazard level A are labelled with an R phrase from R 40 to R 43. In contrast, these phrases are commonly encountered at hazard level B and above.

Classing the data according to the main groups of active substances present in surface disinfectants (**Table 6**) gives a more differentiated picture. Thus, no product in the "aldehydes/aldehyde releasers" group is classed as level A, and all the products in the large group containing these active substances are labelled with an R4x phrase. In contrast, the products containing "alcohols" as their active ingredient are mainly classed in levels A and B, and two-thirds carry no R4x phrase.

**Table 6:** Surface disinfectants: groups of active substances and hazard levels (\*) Indications on the R phrases can be found in subsequent tables

	Total number	Number without R4x	Number with R4x	Hazard level A	Hazard level B	Hazard level C	Hazard level D
<b>Aldehydes/ aldehyde releasers</b>	29	0	29	0	10*	15*	4*
<b>Alcohols</b>	154	103	51	78	68*	8*	0
<b>Alkylamines</b>	22	14	8	0	7*	8*	7*
<b>Amphoteric surfactants</b>	1	1	0	0	0	1	0
<b>Chloride releasers / chloramides</b>	7	2	5	0	1	6*	0
<b>Glycols and derivatives</b>	2	2	0	0	0	2	0
<b>Peroxides</b>	22	19	3	7	7*	4	4
<b>Phenol and derivatives</b>	3	1	2	0	2*	1	0
<b>Quaternary ammonium compounds</b>	233	157	76	39	95*	69*	30*
<b>Acids</b>	5	4	1	0	5*	0	0
<b>Total</b>	478	303	175	124	195	114	45

Tables 7 to 9 show the distribution of R4x phrases for the groups of active substances for each hazard level.

**Table 7:** Surface disinfectants: hazard level B: phrases R40 to R43

	Number	R40	R41	R42	R43	R42/43
<b>Aldehydes / aldehyde releasers</b>	10	5	8	0	2	8
<b>Alcohols</b>	68	0	46	0	1	0
<b>Alkylamines</b>	7	0	6	0	0	0
<b>Peroxides</b>	7	0	3	0	0	0
<b>Phenol and derivatives</b>	2	0	1	0	1	0
<b>Quaternary ammonium compounds</b>	95	0	44	0	2	0
<b>Acids</b>	5	0	1	0	0	0

**Table 8:** Surface disinfectants: hazard level C: phrases R40 to R43

	Number	R40	R41	R42	R43	R42/43
<b>Aldehydes/ aldehyde releasers</b>	15	7	1	0	0	15
<b>Alcohols</b>	8	0	4	0	0	0
<b>Alkylamines</b>	8	1	0	0	0	0
<b>Chloride releasers/chloramides</b>	6	0	0	5	0	0
<b>Quaternary ammonium compounds</b>	69	1	10	0	9	6

**Table 9:** Surface disinfectants: hazard level D: phrases R40 to R43

	Number	R40	R41	R42	R43	R42/43
<b>Aldehydes/aldehyde releasers</b>	4	2	0	0	0	4
<b>Alkylamines</b>	7	0	0	0	1	0
<b>Quaternary ammonium compounds</b>	30	0	0	0	8	0

### 3.2 Instrument disinfectants

The data for the 182 instrument disinfectants were exploited according to the same criteria as for sur-

face disinfectants (section 3.1). The results are presented in **tables 10 to 15**.

**Table 10:** Instrument disinfectants: distribution by hazard levels

Hazard level	Total number	Number without R4x	Number with R4x
<b>A</b>	23	22	1
<b>B</b>	55	24	31
<b>C</b>	78	52	26
<b>D</b>	26	22	4
<b>Total</b>	182	120	62



**Table 11:** Instrument disinfectants: groups of active substances and hazard levels

(\*) Indications on the R phrases can be found in subsequent tables

	Total number	Number without R4x	Number with R4x	Hazard level A	Hazard level B	Hazard level C	Hazard level D
<b>Aldehydes/ aldehyde releasers</b>	26	1	25	0	12*	11*	3*
<b>Alcohols</b>	16	11	5	1*	9*	6*	0
<b>Alkylamines</b>	48	41	7	6	6*	17*	19*
<b>Glycols and derivatives</b>	3	3	0	0	0	3	0
<b>Guanidines/Biguanides</b>	3	1	2	1	0	2*	0
<b>Bases</b>	8	8	0	1	1	6	0
<b>Peroxides</b>	9	8	1	0	6*	2	1
<b>Phenol and derivatives</b>	5	0	5	0	1*	4*	0
<b>Quaternary ammonium compounds</b>	64	48	16	14	20*	27*	3
<b>Total</b>	182	121	61	23	55	78	26

Tables 12 to 15 show the distribution of R4x phrases by group of active substances for the different hazard levels.

**Table 12:** Instrument disinfectants: hazard level A: phrases R40 to R43

	Number	R40	R41	R42	R43	R42/43
<b>Alcohols</b>	1	0	1	0	0	1

**Table 13:** Instrument disinfectants: hazard level B: phrases R40 to R43

	Number	R40	R41	R42	R43	R42/43
<b>Aldehydes/aldehyde releasers</b>	12	6	8	0	1	10
<b>Alcohols</b>	9	0	3	0	0	1
<b>Alkylamines</b>	6	0	4	0	0	0
<b>Peroxides</b>	6	0	1	0	0	0
<b>Phenol and derivatives</b>	1	0		0	1	0
<b>Quaternary ammonium compounds</b>	20	0	11	0	0	1

**Table 14:** Instrument disinfectants: hazard level C: phrases R40 to R43

	Number	R40	R41	R42	R43	R42/43
<b>Aldehydes/aldehyde releasers</b>	11	2	2	0	0	11
<b>Alcohols</b>	6	0	0	0	1	0
<b>Alkylamines</b>	17	0	0	2	0	0
<b>Guanidines/ Biguanides</b>	2	0	1	1	0	0
<b>Phenol and derivatives</b>	4	0	2	0	4	0
<b>Quaternary ammonium compounds</b>	27	0	0	4	1	1

**Table 15:** Instrument disinfectants: hazard level D: phrases R40 to R43

	Number	R40	R41	R42	R43	R42/43
<b>Aldehydes/aldehyde releasers</b>	3	2	0	0	0	3
<b>Alkylamines</b>	19	0	0	0	1	0

### 3.3 Skin and hand disinfectants

Tables 16 to 19 summarise the results obtained by exploiting the data for the 135 skin/hand disinfect-

ants for which a material safety data sheet was available (datasheet not available for one product).

**Table 16:** Skin and hand disinfection: distribution by hazard levels

Hazard level	Total number	Number without R4x	Number with R4x
A	47	45	2
B	74	57	17
C	13	13	0
D	1	1	0
<b>Total</b>	<b>135</b>	<b>116</b>	<b>19</b>

**Table 17:** Skin and hand disinfection: groups of active substances and hazard levels

(\*) Indications on the R phrases can be found in subsequent tables

	Total number	Number without R4x	Number with R4x	Hazard level A	Hazard level B	Hazard level C	Hazard level D
<b>Alcohols</b>	129	110	19	42*	74*	13	0
<b>Iodine-releasers</b>	4	4	0	4	0	0	0
<b>Peroxides</b>	1	1	0	0	0	0	1
<b>Phenol and derivatives</b>	1	1	0	1	0	0	0
<b>Total</b>	<b>135</b>	<b>116</b>	<b>19</b>	<b>47</b>	<b>74</b>	<b>13</b>	<b>1</b>

**Table 18:** Skin and hand disinfection: hazard level A: phrases R40 to R43

	Number	R40	R41	R42	R43	R42/43
<b>Alcohols</b>	42	0	2	0	0	0

**Table 19:** Skin and hand disinfection: hazard level B: phrases R40 to R43

	Number	R40	R41	R42	R43	R42/43
<b>Alcohols</b>	74	0	17	0	0	0

#### 4. Example of application

The data on the hazards and dangerous properties of disinfectant products can be used to establish the hazard profile of the products available on the German market for a given disinfection task, grouped based on their active substances. Thus, for the group of disinfectants with quaternary ammonium as their active ingredient, of 64 products, 14 are classed at hazard level A, 20 are level B, 27 are level C and 3 are level D.

Disinfectant X, in the quaternary ammonium group, can thus have a hazard level from A to D, with or without R phrases (additional R4x indication). If disinfectant X is classed at level C for example, it can be compared to other disinfectants for instruments. If the latter have a higher hazard level (e.g. level D), product X is considered safer (if this is the only point of comparison). However, if we consider the hazard spectrum for all the products available on the market, the approach leads to the conclusion that a disinfectant classed as level C is not optimal, as there are 14 similar products at hazard level A, and 20 at level B, which could be substituted for product X.

#### 5. Conclusion

This inventory of disinfectants and the risks associated with their use provides a profile of safety requirements for product selection:

- Hygienists' requirements should be taken into account when choosing between disinfectants. For example, if a peroxide-based disinfectant for instruments must be used, the safety requirement may be formulated as follows: the ideal product should be ranked at hazard level B and, if possible, not be subject to any obligatory labelling with phrases R40 to R43.
- Occupational health professionals can thus decide the minimal requirements to which the disinfectant must conform based on the hazard profile. This can be used to justify

product selection to a hospital or institution purchasing centre.

In addition to applications for product purchasing, this assessment scheme is a conceptual model for occupational safety training, as the regulatory classification and labelling of dangerous products can be used to present the potential problems with the different product groups in a structured format.

The assessment scheme can be applied to all surface, instrument and skin/hand disinfection products, and the user only requires access to the freely-available product data. Thus, the system depends on the quality of the information available relating to product properties. The indications provided by the manufacturer or the importer must therefore be reliable.

When applying this assessment scheme, it must be remembered that the hazard spectrum for the products available for a given disinfection task is in constant, slow evolution. Information must therefore be constantly updated to adapt the approach to the up-to-date market information.

In addition, changes to the European regulations relating to labelling of chemical products are scheduled. The CLP regulation [6] will require the implementation of a new labelling system from mid-2015 at the latest, when R phrases will be replaced by hazard phrases. In 2015, it will therefore be necessary to entirely review the assessment scheme presented here.

#### References

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

### Factsheet 4: Selecting safe disinfectants

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