research for
man and environment

RIJKSINSTITUUT VOOR VOLKSGEZONDHEID EN MILIEU
NATIONAL INSTITUTE OF PUBLIC HEALTH AND THE ENVIRONMENT

RIVM report 612810 008

Hygienic Cleaning Products Used in the Kitchen

Exposure and Risks

M.C.H. Weerdesteijn, H.J. Bremmer, M.J. Zeilmaker,
M.P. van Veen

October 1999

This investigation has been performed by order and for the account of the Ministry of Health, Welfare and Sports, within the framework of project 612810, Risk assessment for the Consumer.

RIVM, P.O. Box 1, 3720 BA Bilthoven, telephone: 31 - 30 - 274 91 11; telefax: 31 - 30 - 274 29 71

OUTDATED

Abstract

In this study it was examined how people are exposed to compounds in hygienic cleaning products used in the kitchen. The products for which exposure was assessed are dishwashing liquids, hygienic cleaning napkins, spray cleaners and bleach containing products (abrasive, all purpose cleaner and bleach). For each product type, exposure was assessed to one example compound while performing one or two cleaning tasks in the kitchen. The exposure assessments are performed with the computer application CONSEXPO. The calculated exposures are compared to the toxicity of the assessed compounds in order to assess risk. It is concluded that exposure to didecyl dimethyl ammoniumchloride when using a hygienic cleaning trigger spray might cause slight dermal irritation. Exposure to the assessed compounds when using the products for cleaning tasks in the kitchen is not expected to cause adverse health effects, based on a first toxicological screening.

Contents

Summary

Recently a number of hygienic cleaning products have been introduced on the market. These products are defined as: “cleaning products meant for the control of multiplication and spread of micro-organisms”.
In this study it was examined how people are exposed to compounds in hygienic cleaning products used in the kitchen.

For the selection of hygienic cleaning products used in the kitchen, an inventory of products was made. Products were selected if the product label stated that they clean hygienic or disinfect, and if they could be used in the kitchen. The brand products encountered in the inventory belong to the categories dishwashing liquids, hygienic cleaning napkins, spray cleaners, abrasives, all purpose cleaners and bleach.

It was examined for which applications the products are used in the kitchen. For each product type, one or two cleaning tasks were selected for the exposure assessments. This selection was based on the frequency of product use for the task and on the expected intensity of exposure, in order to include those tasks for which risks can be expected.

To answer the question if harm is expected it is necessary to understand the composition of the products. For each product type, one compound was selected for which exposure and risks are assessed. The selection was based on the hazardous properties of the compound, on the concentration in the product and on compound characteristics like volatility.
The compounds selected are: glutaraldehyde (for dishwashing liquid), isopropylalcohol (for hygienic cleaning napkins), DDAC (didecyldimethyl ammoniumchloride) (for spray cleaners) and sodiumhypochlorite (for the bleach containing products: abrasive, all purpose cleaner and bleach).

Exposure to the selected compounds as a result of the use of cleaning products for the selected tasks, has been assessed with the computer application CONSEXPO 3.0. This application is especially designed for the assessment of exposure to compounds in consumer products. It offers the possibility to choose a contact and a specific exposure scenario for each route of exposure (dermal, inhalation and oral) that is best suitable to the form of the product and to the way in which a product is used.

Finally the risks of exposure to the compound have been assessed by comparing exposure and effects. No adverse health effects are expected to occur due to exposure to the selected compounds for the use of dishwashing liquid, hygienic cleaning napkins and bleach containing products. However, when comparing toxicity data from literature to the results of the exposure estimate of hygienic cleaning spray cleaners, it is concluded that when undiluted contact occurs to a DDAC containing product, slight dermal irritation might occur.

In Table I the results of the dermal, inhalation and oral exposure and risk assessments are summarised.

Table I. Inhalation, oral and dermal exposure and risks

Product type	Selected Compound	Selected cleaning task	Dermal		Inhalation		Oral	
			Exposure* (mg/cm^3)	Risk	Exposure* (mg/m^3)	Risk	Exposure* (mg/day)	Risk
Dishwashing liquid	Glutaraldehyde	Washing up	$1.02*10^{-3}$	- -	$7.9*10^{-7}$	- -	0.8	- -
		Cleaning hands	1.02	-	$3.9*10^{-5}$	- -		
Napkins	Isopropylalcohol	Working top	50	- -	$2.3*10^{1}$	- -	0.03	- -
Spray cleaners	DDAC	Working top	2	+ / -	$3.2*10^{-4}$	?	0.032	- -
Bleach containing products	Hypochlorite ion†	Sink	52 – 75**	- -				
		Working top	52 – 75**	- -				
		Floor	$4.7*10^{-1}$	- -			0.0195	- -
	Hypochlorous acid†	Sink			$2.8*10^{-13}$	- -		
		Working top			$4.5*10^{-12}$	- -		
		Floor			$3.2*10^{-14}$	- -		

* Exposure is here: mean event concentration

** Dermal exposure differs for the three bleach-containing products within this range

- - No adverse effects expected

\- Exposure is at same level as the highest level reported in literature at which no effects are found, however, possibility of occurrence of effects is considered to be low

+/- Possible occurrence of slight dermal irritation

? No data on inhalation toxicity available

† In aqueous sodiumhypochlorite solutions, the compound dissociates in hypochlorite ion and hypochlorous acid.

Samenvatting

De laatste tijd is een aantal hygiënisch reinigende producten op de markt gebracht. Hygienisch reinigende producten zijn in deze studie gedefinieerd als reinigingsmiddelen met het doel de groei en verspreiding van micro-organismen tegen te gaan.
In dit onderzoek is bestudeerd hoe mensen blootgesteld zijn aan stoffen in deze producten.

Er is een inventarisatie gemaakt van die hygiënisch reinigende producten die worden gebruikt in de keuken. Producten zijn meegenomen in de studie als op hun etiket vermeld was dat deze hygiënisch reinigen of desinfecteren en (mede) bedoeld zijn voor gebruik in de keuken.

De geïdentificeerde producten behoren tot de productcategoriën: afwasmiddelen, hygiënisch reinigende doekjes, sprayreinigers, schuurmiddelen, allesreinigers en bleekmiddelen.

Onderzocht is voor welke taken in de keuken deze producten worden gebruikt. Per product categorie zijn één of twee taken geselecteerd voor de blootstellingsschattingen. De selectie is gemaakt op basis van de frequentie van gebruik en op basis van de verwachte expositie.

Om de vraag te beantwoorden of blootstelling tijdens het gebruik van deze producten kan leiden tot risico's is het tevens van belang te weten wat de samenstelling is van de producten. Voor ieder product is de samenstelling achterhaald. Vervolgens is per productcategorie één stof geselecteerd voor de blootstellings- en risicoschattingen. De geselecteerde stoffen zijn glutaraldehyde (voor afwasmiddel), isopropylacohol (voor hygienisch reinigende doekjes), DDAC (didecyldimethylammoniumchloride) (voor hygienisch reinigende spray reinigers) en natriumhypochloriet (voor bleekhoudende middelen: schuurmiddelen, allesreinigers en bleekmiddelen). Deze selectie van stoffen is gebaseerd op de schadelijke eigenschappen van de stoffen, de concentratie in het product en op stofeigenschappen zoals de vluchtigheid.

De blootstelling aan de geselecteerde stoffen ten gevolge van het gebruik van de reinigingsmiddelen voor de geselecteerde taken is geschat met behulp van het computer model CONSEXPO 3.0. Dit model is speciaal ontwikkeld voor het uitvoeren van blootstellingsschattingen voor stoffen in consumentenproducten. Voor iedere blootstellingsroute (dermaal, inhalatoir en oraal) kunnen verschillende scenario's worden gekozen die het best passen bij de vorm van het product en de manier waarop het wordt gebruikt.

Tot slot is het risico van blootstelling aan de geselecteerde stoffen geschat, door de berekende blootstelling te vergelijken met toxiciteitsgegevens. Op basis van deze vergelijking is geconcludeerd dat bij het gebruik van afwasmiddel, hygienisch reinigende doekjes en bleekhoudende middelen geen schadelijke effecten voor de gezondheid verwacht worden ten gevolge van blootstelling aan de bestudeerde stoffen. Wanneer echter de toxiciteitsgegevens van DDAC worden vergeleken met de dermale blootstelling via het gebruik van een spraycleaner, blijkt het mogelijk dat lichte irriterende effecten op de huid optreden.

In Tabel I (pagina III) zijn de resultaten van de dermale, inhalatoire en orale blootstellings- en risicoschattingen samengevat.

1 Introduction

Recently several new ‘hygienic cleaning’ products have been introduced for domestic use. This is accompanied with many television and magazine advertisements emphasising the hygienic cleaning capacities or even stating that the product kills 99.9% of the bacteria present in the household; suggesting disinfection (Hulzen, 1999). hygienic cleaning products are in this study defined as products meant for the control of multiplication and spread of micro-organisms in the home environment.

While cleaning, people are potentially exposed to compounds emerging from cleaning products. These compounds also contribute to contamination of the indoor environment after cleaning (Wolkoff *et al.*, 1998). The hygienic cleaning capacities of products raised the question what compounds would be present, and if exposure can constitute a threat to human health.
Exposure to compounds in cleaning products might lead to considerable levels, because the product is used repetitively during a person’s entire life span. Besides exposure due to the use of these cleaning products, additional exposure can occur when the compound is also present in other products and the environment (Weegels, 1997).

Within the framework of the RIVM-project ‘Consumer Risk Assessment’ descriptive models are developed to assess exposure to compounds in consumer products. Exposure is separated into contact; dermal, inhalation and oral exposure; and uptake. The models are integrated in the computer application CONSEXPO 3.0. By joining different models and different routes, the program copes with consumer product diversity. To anticipate on future questions about exposure to compounds in consumer products, information relevant for exposure estimates is gathered.

The aim of this study is to collect the information necessary to describe exposure to compounds in hygienic cleaning products, to assess exposure to compounds in these products and to examine if exposure to these compounds might lead to adverse health effects when using these products for cleaning. The scope of this study is limited to products used in the kitchen, where many cleaning products are used regularly.

The central questions underlying this study are:

- *How are consumers exposed to hygienic cleaning products used in the kitchen?*
- *Is there harm expected for human health?*

Exposure estimates for consumers require understanding of consumer habits and practices. These include the variety of uses, relevant routes of exposure and of use related parameters necessary for a description of exposure (e.g. the frequency and duration of product use) and knowledge of the concentration of the substance in the product (Hakkinen *et al.*, 1991; ECETOC, 1994).

In chapter 2 the product category ‘hygienic cleaning products used in the kitchen’ is defined, and the products within this category are listed. Chapter 3 discusses the applications and use of the identified products. Per product tasks are selected for the exposure assessment. In chapter 4 the composition of the products is outlined and it is described which compound in each product is chosen for the exposure assessment. In the chapter on the actual exposure assessments, chapter 5, exposure is modelled to compounds in the specific cleaning products for one or more tasks in the kitchen. It is described what models and parameters are used in the assessments. In chapter 6 the risk assessment, exposure is compared with the toxicity via the dermal, inhalation and oral route to examine if exposure to the selected compounds might lead to adverse health effects, following the use of hygienic cleaning products in the kitchen. Finally, a discussion and conclusion is presented.

2 Hygienic cleaning products used in the kitchen

2.1 Definition

The scope of this study is limited to the description of the use and exposure assessment for *hygienic* cleaning products used in the kitchen. Over the past year several new products are introduced on the market that clean hygienically or disinfect. Some hygienic cleaning products appear as disinfectant in their commercial, in fact closing the gap between cleaning and disinfecting. For use in the kitchen, several classical products exist and a number of new products have been introduced.

The broad term hygiene refers to the science of the establishment and preservation of health (Terpstra, 1998; Webster, 1996). The practice of hygiene concentrates especially on manipulating and controlling the environment for the benefit of human health. It is therefore concerned with housing, water supplies, personal care and food (Terpstra, 1998). However, when speaking of hygiene, the meaning is often reduced to the control of micro-organisms in the (home) environment, by taking action to limit their multiplication and spread (Van den Wijngaard, 1987).

In this study, hygienic cleaning products are defined as '*cleaning products meant for the control of multiplication and spread of micro-organisms*'.

Since disinfection refers to the elimination or irreversible inactivation of contaminating micro-organisms (Terpstra, 1998; Wolkoff *et al.*, 1998), disinfecting cleaning products are in this study also included as hygienic cleaning products. Disinfecting products in the Netherlands must all be approved by the 'Board for the admission of pesticides' (CTB) (Vollebregt *et al.*, 1994). For approval, such products need to be assessed on their effectiveness as well as on their environmental and human health impacts (Rohde, 1994).

Although most suppliers of the newly developed hygienic cleaning products do not literally state that these products are meant to decrease the number of micro-organisms, this is certainly implied in the advertisements in magazines and commercials on television. This is also concluded by Scholtens (1998), who states that the word micro-organisms is not mentioned in European campaigns since it would only put off people. However, a spokesman of Procter and Gamble recognised (after urging by Scholtens) that, among other things, the word hygiene in Dreft extra hygiene relates to decreasing the number of micro-organisms (Scholtens, 1998).

2.2 Products

By visiting various supermarkets, an inventory was made of readily available products belonging to the category of hygienic cleaning products. A product was only included if its label indicated that it would clean hygienically or would disinfect. Another inclusion criterion was that the label should somehow indicate the product was either especially, or among other things designed for use in the kitchen.
The Dutch supermarkets visited are Konmar Superstore (Zoetermeer), Albert Heijn (Bilthoven), and Bonimarkt (Bilthoven). This identification took place in December 1998. In February 1999, a new hygienic cleaning dishwashing liquid was introduced which was also included in the study. Machine dishwashing liquids are left out of consideration here, because of limited exposure during use. The brand products identified are listed in Table 1. The products are categorised according to their function.

Table 1. Hygienic cleaning products used in the kitchen

Product type	**Products**
Dishwashing liquid	Dreft Extra Hygiene
	Dubro Extra Hygiene
Napkins	Glorix hygienic cleaning napkins
Spray cleaner	Glorix hygiene expert kitchen cleaner
	SanaSept disinfecting spraycleaner
All purpose cleaner	Ajax Gel 2 in 1
	Andy Plus
Liquid abrasive	Jif Active
	Casa abrasive with bleach
Bleach	Glorix hygiene expert
	Loda Bleach

This overview is quite complete for universal brand products. After visiting some more supermarkets from December 1998 to February 1999, it was concluded that the above listed products were available in most supermarkets. The variance in supply between supermarkets is limited to the specific supermarket brands. Most supermarkets have their own generic brand of various products such as bleach, abrasive, and dishwashing liquid. Since there are many different generic brands, and because of the small differences in composition between the various generic brands within one product category, only universal brand products are included in the study.

The selection of products in Table 1 gives an overview of hygienic cleaning products used in Dutch kitchens. In this study, exposure is assessed to compounds present in these products.

3 The use of hygienic cleaning products

Different applications of products can cause different exposure because of the divergent way in which the product is used for various cleaning tasks. Therefore, applications of products and the way in which they are used are of importance to exposure assessments. Consider for example diluted versus undiluted use, or a short use duration versus prolonged.

In this chapter, the following is described for each product type:
- The applications of the product in the kitchen;
- The selection of cleaning tasks for the exposure assessments;
- How products are used for the selected tasks.

The selection of tasks is based on the frequency of use and on the expected intensity of exposure. For example, exposure to undiluted product is more intense than exposure to diluted product.

3.1 Applications and use of dishwashing liquid

Applications

Dishwashing liquid is mainly used for washing up. However, it is also used for a wide variety of other tasks, see Table 2 (Weegels, 1997).

Table 2. Applications of dishwashing liquid

Application	Households (N=28)*	Number Of times	Application	Households (N=28)	Number Of times
Dishes, including kitchen sink and working top	28	532	Car windows	2	4
Gas stove	12	64	Trousers	2	2
Dining table	9	21	Oven/microwave	2	2
Kitchen floor	6	22	Exhaust fan/register	2	3
Cage for animals	5	31	Glasses	1	10
Tiles	3	10	Litter bin	1	3
Kitchen cupboards	3	4	Cleaning hands	1	2
			Various	1	1

* 28 households reported the tasks for which dishwashing liquid was used

Among these applications, tasks relevant for exposure assessment within the framework of this study are: doing the dishes and cleaning hands. Doing the dishes is considered relevant because dishwashing liquid is used in the kitchen most frequently for this task. Cleaning hands with dishwashing liquid is selected because of exposure to undiluted product. Other tasks are considered less relevant for exposure either because of low use frequency, low exposure or irrelevancy for use in the kitchen. Cleaning the kitchen floor was always mentioned subsequently to doing the dishes. It is concluded that cleaning the kitchen floor means the drying of spillings with a cloth rinsed in dishwater after doing the dishes. Exposure is therefore comparable to exposure when doing the dishes.

Use

Doing the dishes

The common procedure for doing the dishes by hand, is to dip (rinsed) articles into a diluted solution of the dishwashing detergent and to remove the food residues with a brush, sponge or cloth. The temperature of the soapsuds should be between 40 and 45 ^{0}C (Falbe, 1987). Sometimes items are rinsed under running water or in a separate bowl after cleaning. The reasons for rinsing can be to prevent streaks, to remove foam or to prevent oral exposure to dishwashing liquid (Weegels, 1997). Finally the washed items are either left in a rack to dry or dried with a tea towel (Falbe, 1987; Weegels, 1997). Weegels (1997) concludes that most people dry the dishes with a tea towel (Weegels, 1997).

In Southern European and Southern American countries the practice of dishwashing differs from the one described above. There, no soapsuds are used when washing up. The liquid is dashed directly on a moist sponge or cloth or on the dishes, after which they are cleaned under running water (Falbe, 1987). This procedure is also observed in the Netherlands for 2 out of 28 subjects (Weegels, 1997).
In this study, exposure is modelled when doing the dishes with soapsuds, as this is the common procedure in the Netherlands.

Cleaning hands

Hands can be cleaned with dishwashing liquid in several ways. One can clean one's hands in a soapsuds. However, in this study it is assumed that when dishwashing liquid is used for cleaning hands, it is dashed directly onto the hands. After that, the hands are washed with a little water. The latter procedure is selected for the exposure estimate, as it implies contact with undiluted dishwashing liquid.

3.2 Applications and use of napkins

Glorix hygienic cleaning napkins are solid, wetted cleaning napkins. They are approximately 0.3 mm thick, 19.5x18 cm and slightly elastic in only one direction. The fraction cleaning product in the napkins is determined by weighting them before and after drying. This is described in Appendix 1. The weight of the napkins when taken from the package is approximately 5.7 g, with a 'wet fraction' of 3.4 g.

Applications

According to the use instruction on the label of the product, the napkins can be used in the kitchen for cleaning all washable surfaces such as the kitchen working-top, tiles, stainless steel and synthetic material.

The application chosen for the exposure estimate is cleaning the kitchen working top, as this is the largest area in the kitchen that is cleaned with these napkins.

Use

The napkins are ready for use when taken from the package. The product is simply used by wiping the surface. They are suitable for use once only. After use, it is not necessary to rinse the surface, and the napkins are thrown away.

3.3 Applications and use of spray cleaners

Figure 1. Spray cleaner

The two identified hygienic cleaning spray cleaners are products in a bottle and can be applied only by spraying. The term spray cleaner refers to a product as shown in Figure 1.

Applications

The hygienic cleaning spray cleaners are suitable for cleaning all washable surfaces. In Table 3 the applications of these products in the kitchen are listed according to their labels.

Table 3.Applications of hygienic cleaning triggersprays

Application	Reference
Kitchen working top	Label SanaSept, Glorix
Fridge	Label SanaSept
Sink	Label SanaSept
Cutting board	Label SanaSept
Microwave	Label SanaSept
Tiles	Label Glorix
Stainless steel	Label Glorix
Synthetic material	Label Glorix

In this study, exposure is assessed when cleaning the kitchen working top. The kitchen working top is the largest area in the kitchen cleaned with these products. As the products is used in the same manner for all purposes, exposure during the performance of other tasks will be comparable.

Use

According to the use instruction, the spray cleaners should be used in three phases. First, the product is sprayed onto the surface. It is advised to leave the product on the surface to soak in for five minutes. Finally, the surface should be rinsed or taken off with a wet cloth.
However, it is concluded from literature and from a pilot study performed within the framework of this study, that products are not always used according to the use instruction. In the pilot, four out of five subjects did not leave the product to soak in, and three out of five subjects cleaned the surface with a dry in stead of a wet cloth. For a description of the pilot study, see Appendix 5.

3.4 Applications and use of bleach containing products

Bleach, hygienic cleaning abrasive and hygienic cleaning all-purpose cleaner are all bleach containing products. They are discussed here together for three reasons.

1. All three products have the capacity to bleach stains. This implies usage for the same kind of tasks;
2. The products are used alike for similar tasks;
3. The concentration bleach in the products is for all products specified as a concentration of up to 5% (see also paragraph 4.5).

Here the applications of the products and the way in which products are used are described.

Applications

The tasks in the kitchen for which the bleach containing products are used, are summarised in Table 4. An ‘x’ indicates that the product is used for that particular task. The numbers in superscript refer to the reference in which this particular task is mentioned. The tasks placed in the category ‘Other’ are either unusual tasks for the particular product, or in the case of all purpose cleaner, not likely to be done with hygienic cleaning all purpose cleaner.

Table 4. Applications of bleach containing products in the kitchen

Task	Bleach	Abrasive	All purpose cleaner
Kitchen working top	x [1,2]	x [1,2,4]	x [1,2,4]
Kitchen sink	x [1,3]	x [1,4]	x [1]
Floor	x [3]		x [1,4]
Litter bin	x [3]		x [1]
Tiles		x [4]	x [1]
Gasstove		x [1]	x [1]
Pans		x [1]	x [1]
Oven			x [1]
Cupboards			x [1]
Table			x [1]
Doors			x [1]
Fridge			x [1]
Other		x [1]	x [1]

[1] Weegels (1997); [2] Consumentenbond, 1998; [3] Siderius & Van Haren (1992);
[4] Use instruction of products

The tasks chosen here for the exposure assessment are: cleaning the kitchen working top and the kitchen sink with undiluted product, and cleaning the floor with diluted all-purpose cleaner. These tasks were chosen because the products are generally used for these tasks, and to examine the difference in exposure between diluted and undiluted use.

Use

Bleach

Bleach is used in the household for cleaning (removal or bleaching of stains and odours) and ‘disinfecting’ purposes (AISE, 1997). The product can be used both diluted and undiluted according to the use instructions. After use the surface should always be rinsed well.

Abrasive

hygienic cleaning abrasive is liquid abrasive containing a scouring component such as calcium carbonate besides bleach and surfactants. The product is applied either directly onto the surface to be cleaned, or on a moist cloth used for cleaning. According to the use instructions, it is advised leave the product to soak in for a moment, after which the surface can be cleaned. After use, the surface needs to be rinsed off well.

All purpose cleaner

All-purpose cleaners are used for cleaning various hard surfaces like windows, mirrors and floors (Vollebregt *et al.*, 1994). The product can be used both diluted and undiluted. For diluted use soapsuds is prepared. A sponge, cloth or mop rinsed in it is used for cleaning. According to the producer the surfaces are supposed to be clean and residue free after drying without rinsing or further wiping. For localised stubborn soil deposits, all-purpose cleaners can also be applied undiluted. In this case after-wiping or rinsing is necessary (Falbe,1987).

It is here assumed that although bleach, abrasive, and all-purpose cleaner are three different products, they are used in the same manner for the selected tasks. When either of these products is used for cleaning the sink or the kitchen working top they are used undiluted. When all-purpose cleaner or bleach is used to clean the kitchen floor, it is used diluted.

4 Product composition

In this chapter on the composition of the selected cleaning products, the following aspects are outlined:

- The *method* of retrieving information about the composition of the products;
- The *composition* of the products;
- The *compounds* selected for the exposure assessment and their properties.

4.1 Method of retrieval

Several European directions and recommendations made it possible to retrieve information on the concentration or concentration range of hazardous substances in the identified products. They regulate the provision of information on the contents of cleaning products. This legislative framework is outlined here.

The provision of information on the compounds in cleaning products is regulated by the EC directive on the classification, packaging and labelling of dangerous preparations (78/631/EEC). All dangerous preparations (a mixture of one or several substances) must be classified and labelled before being marketed. Once a preparation has been classified under one or more categories, labelling follows according to that classification by means of standardised warnings, safety advice phrases and symbols. Furthermore, all substances classified as toxic, very toxic or corrosive must be indicated when their content is greater than the concentration limit (Mosselmans, 1992).
If a preparation is classified as dangerous, the person responsible for placing it on the market (manufacturer, importer or distributor) is obliged to supply the recipient (an industrial user) with a safety data sheet (91/155/EEC). One of the 16 obligatory headings is ‘Composition/information on ingredients’, which should enable the recipient to identify the risks attaching to the substance or preparation. It is not necessary to give the full composition (EU, 1991). However, all substances classified as hazardous and present in a concentration exceeding the concentration range as laid down in article 3 of directive 88/379/EEC need to be indicated together with their concentration or concentration range (EU, 1991).
Besides, according to an EEC recommendation concerning the labelling of detergents and cleaning products (89/542/EEC), some compounds added to the product in a concentration of more than 0.2% should be listed here as well (Vollebregt *et al.*, 1994; EU, 1989).

To identify the composition and potentially hazardous substances in each of the products listed in Table 1, the ingredient information on labels was studied and product safety data sheets were retrieved. The level of detail complied with the EU directions in all retrieved product safety data sheets. The sheets of some products were more detailed than obligatory. General product information was added to the product specific information. In the next section, the composition of the products is described together with the compound chosen for the exposure estimates.

4.2 Composition of dishwashing Liquid

The primary components of manual dishwashing detergents are anionic surfactants, such as linear alkylbenzene sulfonates. Throughout the world, five surfactant groups are utilised as primary surfactants for dishwashing detergents. These are: linear alkyl benzene sulfonates (LAS), alkane sulfonates (AS), α-olefin sulfonates (AOS), fatty alcohol sulfates (FAS), and fatty alcohol ether sulfates (FES). The range of surfactant concentration is very broad; most products contain between 10% and 40% surfactant. Detergents with a content exceeding 10% comprise auxiliary components such as hydrotropes to increase the solubility of the surfactants in water and to assure clear homogenous and storage stable products. Examples of hydrotropes commonly used are cumene sulfonate, xylene sulfonate and alcohols.

Additional components of dishwashing detergents are dyes, fragrances, and preservatives mostly in concentrations below 1%. Dyes provide optically more pleasant products. The function of fragrances is to mask the inherent odour of the raw materials and unpleasant fragrances of food residues and to produce a pleasant odour for the product itself (Falbe, 1987). Because of the neutral properties of dishwashing liquid, preservatives are added to protect the product against micro-organisms (Vollebregt & Van Broekhuizen, 1994). Contamination with micro-organisms might affect product properties like pH, turbidity, colour, and odour. Dishwashing liquids contain either single preservatives or combinations. Sometimes, skin protection agents are added to the detergents to improve skin compatibility. Examples are fatty acid alkanol amides, glycol stearates and betaines. The cleaning process is affected by various metals; major surfactant combinations perform better in hard water than they do in soft water. The degree of cleaning can be increased by addition of bivalent cations preferably magnesium salts (Falbe, 1987).

In Table 5 the typical formulation of manual dishwashing liquid is described according to literature, together with the formulation of the 'hygienic' dishwashing products, 'Dreft Extra Hygiene'and 'Dubro Citron Extra Hygiene', according to their product safety data sheets.

A compound in the perfume added to Dreft Extra Hygiene, a terpene, is together with sodium cumene sulphonate responsible for the hygienic cleaning properties of this product (P&G, 1999). The hygienic cleaning properties of Dubro Extra Hygiene can be ascribed to a combination of amphoteric surfactant (alkylbetaine), non-ionic surfactants and 'other' unspecified ingredients. Alkylbetaine is a component that is not added to the 'regular' dubro dishwashing liquid (Lever Fabergé, 1999).

Table 5. Formulation of dishwashing liquid

	General formulation* (Falbe,1987) (%)	Dreft Extra Hygiene (P&G, 1998)** (%)	Dubro extra hygiene (Lever, 1999)** (%)
Water	Balance	50-55	?
Non-ionic surfactants	}	25-30 AEO 0-5 amine oxide	
Anionic surfactants	}10-40		5-15
Amphoteric surfactants	}	0-5 betaines	1-5 alkylbetaine
Hydrotropes	0-6	0-5 ethoxylated alcohol, 0-5 cumene sulphonate, 5-10 denaturated ethanol***, 0-5 polyethylene glycol	
Preservatives	0.1	0-5 glutaraldehyde, 5-10 denaturated ethanol***	
Fragrances	0.1-1	0-5	
Dyestuffs	0.1	0-5	
Salts			
Minor ingredients (skin protection agents, polimers)	0.1	0-5 glucose amide	
pH adjustment			<1 citric acid

* General formulation according to literature
** Product specific formulations according to the product safety data sheets
*** Denaturated ethanol can be added both as hydrotrope and as preservative

Glutaraldehyde is the compound chosen for the exposure estimate. It was chosen for two reasons: (a) for its hazardous properties and (b) because it is added to a product that is used regularly.

The compound characteristics of glutaraldehyde relevant for exposure estimates are outlined in paragraph 4.2.1.

4.2.1 Glutaraldehyde

Glutaraldehyde is a preservative added to hygienic cleaning dishwashing liquid in a concentration of 0-5% (P&G, 1998; Falbe, 1987). More specifically, this concentration range is specified as below 0.1% (P&G, 1999).
The compound is reactive and polymerises in water depending on pH and temperature (NOHSC, 1994; Gorman & Scott, 1980). This property probably led to the widely divergent vapour pressures reported in literature depending on the mixtures. Pure glutaraldehyde has a vapour pressure of 17 mm Hg, a 2% aqueous solution of 0.0012 mm Hg (Beauchamp *et al.*, 1992; NIA/VNCI, 1995; HSE, 1997; NOHSC, 1994; Proscitech, 1999; Richardson & Gangioli, 1994). Anderson (1996) reports that addition of ethanol prevents glutaraldehyde from polymerisation. Because ethanol is also added to dishwashing liquid, the vapour pressure used here for the exposure estimate is 0.0152 mm Hg, the vapour pressure of a 50% aqueous solution (HSE, 1997). Several compound characteristics influence exposure. These characteristics are also needed by CONSEXPO in order to assess exposure. They are summarised in Table 6.

Table 6. Compound characteristics of glutaraldehyde

		Reference
Molecular formula	$C_5H_8O_2$	
Cas number	111-30-8	
Molar weight	100.13 g/mol	
Vapour pressure	0.0152 mm Hg	NOHSC (1994); HSE (1997)
Log K_{ow}	-0.01 (50% solution)	NOHSC (1994)
Water solubility	In all proportions: $1*10^6$ g/l	NOHSC (1994)

4.3 Composition of napkins

According to the product safety data sheet, hygienic cleaning napkins consist of non-ionic surfactants (ethoxylated alcohol) for <1%, of isopropylalcohol for 1-5% and of an unspecified solvent for 1-5% (Lever, 1998).
Based on these data it is concluded that isopropylalcohol is the compound responsible for the hygienic cleaning capacities of the napkins. This is also the compound chosen for the exposure estimates. In paragraph 4.3.1, the properties of isopropylalcohol affecting exposure are described.

4.3.1 Isopropylalcohol

Isopropylalcohol is a colourless, volatile liquid. Its vapour is heavier than air. The fysico-chemical properties of isopropylalcohol are described in Table 7.

Table 7. Compound characteristics of isopropylalcohol

		Reference
Molecular formula	C_3H_8O	
CAS-number	67-63-0	
Molar weight	60.1 g/mol	NIA/VNCI (1995)
Log K_{ow}	0.14	WHO (1990a)
Water solubility	Infinite	WHO (1990a)
Vapour pressure	33 mm Hg	WHO (1990a)

4.4 Composition of spray cleaners

No general formulation for the hygienic cleaning spray cleaners is available. The reason is that both products belonging to this category are fairly new products. The most important difference between the two sprays is that SanaSept disinfecting spraycleaner claims to disinfect whereas glorix hygiene expert kitchen cleaner only states to clean, degrease and to result in hygienic clean surfaces. The composition of both hygienic cleaning spray cleaners is described in Table 8.

Table 8. Formulation of hygienic cleaning spray cleaners

	Glorix kitchen cleaner (Lever Fabergé, 199.)	SanaSept disinfecting spraycleaner (CTB, 1996)
Non ionic surfactants	5-15%	
Amphoteric surfactants	1-5% alkane sulphonate	
Cationic surfactant		Didecyldimethylammoniumchloride 2%
Polycarboxylates	Present	

SanaSept contains 2 g/l didecyl dimethyl ammoniumchloride (DDAC). DDAC is compound that belongs to the category of cationic surfactants (CTB, 1996). This compound is responsible for the disinfecting properties in the product. The product is approved by the board for the admission of pesticides. For approval, the product is assessed on its effectiveness as well as on the environmental and human health impacts (Vollebregt *et al.*, 1994).
DDAC is the compound chosen for the exposure estimates. In the next paragraph, compound properties of DDAC are described.

4.4.1 Didecyl dimethyl ammoniumchloride

DDAC is a quaternary ammonium compound that is characterised by 2 methyl groups and 2 alkyl groups (see Figure 2). It is slightly volatile compound that markedly decreases the surface tension of aqueous solutions. It is a compound that can be used as a disinfectant (Van Hoeven & Van Leeuwen, 1994). The compound characteristics used in the exposure estimates are listed in Table 9.

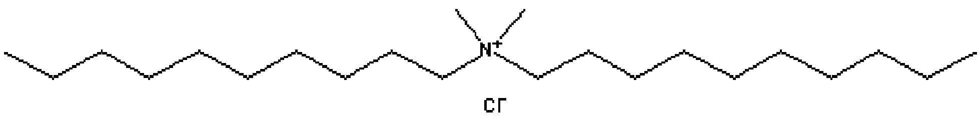


Figure 2. Didecyl dimethyl ammoniumchloride

Table 9. Compound characteristics of DDAC

		Reference
Bruto formula	$C_{22}H_{48}ClN$	
CAS	7173-51-5	
Molar weight	362.1 g/mol	NIA/VNCI (1995)
Vapour pressure	$5.6*10^{-6}$ mm Hg	De Jong (1996)
Log K_{ow}	4.66	Epiwin estimate
Water solubility	0.5505 mg/l	Epiwin estimate

4.5 Composition of bleach containing products

All purpose cleaner
Hygienic cleaning all purpose cleaner is an all purpose cleaner to which bleach (sodiumhypochlorite) is added as an extra component. All purpose cleaners consist of water,

surfactants (anionic and non-ionic), builders and sometimes solvents (e.g. ethanol, methoxypropanol). Additives added to the products are preservatives, fragrance and dyestuffs. The function of the anionic surfactants is to remove dirt, whereas the non-ionic surfactants are meant to remove grease and to prevent the lather from sagging (Vollebregt,*et al.*, 1994). Soap is often added to inhibit excessive formation of lather. Builders are meant to increase the activity of surfactants, by binding metal ions (Smit & Visser, 1987). When solvents are added, their function is to increase the solubility of surfactants and to make the cleaned surface dry quicker, more shiny and without streaks (Vollebregt *et al.*, 1994). The general and product specific formulation of all-purpose cleaner are outlined in Table 10.

Table 10. Formulations of all-purpose cleaners (Falbe, 1987)

Ingredients	Falbe (1987)	Falbe (1987)	Vollebregt *et al.*(1994)	Colgate Palmolive (1995)	Lever Fabergé (1999b)
	Non disinfecting (%)	Disinfecting (%)		Ajax 2 in 1 (%)	Andy plus (%)
Surfactants	**	**	5-13		
Anionic surfactants	1-10	0-10	1-7.5	Soap (<5)	<5
Nonionic surfactants	1-10	1-10	0-5	Nonionics (<5)	
Organic polymers	0-2	0-2	**		
Sequestering agents	1-10	1-10	**		
Alkaline salts / bases	0-10	0-10	**		
Abrasives	-	-	**		
Solvents	0-10	0-20	0-10		
Disinfecting/bleaching agents	-	0.1-15	**	1-5 NaOCl	<5 NaOCl
Preservatives	0-0.2	-	<1		
Skin protection additives	0-2	0-2	**		
Viscosity regulators	0-5	0-5	**		
PH regulators/buffers	0-2	0-2	**		
Builders (soda)	**	**	1-5	NaOH (0.5-2)	Polycarboxylates <5
Hydrotropes	0-10	0-10	**		
Dyestuffs/fragrance	0.05-1	0.05-1	<1		
Water	Balance	Balance	75-80		

** not mentioned

Hygienic cleaning abrasive

Liquid abrasives consist of water, surfactants and a scouring agent. The surfactants decrease the adherence of dirt to the surface and keep the dirt in solution. Calcium carbonate is the scouring agent present in liquid abrasive. Sodiumhypochlorite (bleach) is added as the hygienic cleaning component. The general formulation according to literature and the product specific information according to their product safety data sheets are described in Table 11.

Table 11. Formulation of hygienic cleaning abrasive

	General formulations (%)		Jif (%)	Grada (%)
	Falbe, (1987)	Vollebregt *et al.* (1994)	Lever Fabergé (1996)	Grada (1998)
Anionic surfactants	0-10	2-3.5	<5	<5
Soap			<5	
Nonionic surfactants	0-10	1.5-5	<5	<5
Organic polymers	0-5			
Sequestering agents	0-10			
Alkaline salts / bases	0-10			
Abrasives	20-60	30-50	30-50 $CaCO_3$	
Solvents	0-5			
Disinfecting/bleaching agents	-		<5 NaOCl	<10 NaOCl
Preservatives	0-0.2	<1		
Skin protection additives	0-2			
Viscosity regulators	0-2			
PH regulators/buffers	0-5			<5
Hydrotropes	0-5			
Dyestuffs/fragrance	0.05-1	<1 each		
Water	Balance	40-60		

Bleach

Various types of bleach can be identified.

- solutions of sodium hypochlorite and water only;
- aqueous hypochlorite solution to which surfactants are added;
- thick bleaching agents, which have a higher viscosity than others.

Again, the hygienic cleaning properties can be ascribed to sodium hypochlorite.
The general formulation of household bleach is described in Table 12.

Table 12. Formulation of bleach

	General formulation (Versar, 1989)	Glorix Lever Fabergé, (1993)	Loda bleek
Water	>75%		
Amphoteric surfactants	**	<1%	
Non ionic surfactants	**		
Sodiumhypochlorite	5-10%	1-5%	<5%
Sodium chloride	0.5-5%		
Sodium carbonate	0.5-2%		
Sodiumhydroxide	<0.5	0.5-1%	

Since the hygienic cleaning properties of the bleach containing products can be attributed to sodiumhypochlorite, this is the compound selected for the exposure estimates. In the next paragraph, the chemistry of sodiumhypochlorite is described.

4.5.1 Sodiumhypochlorite

When sodium hypochlorite is dissolved in water, two reactive chlorine species are generated, hypochlorous acid (HOCl) and hypochlorite ion (OCl^-) (see equations 1 and 2). The relative amounts of the active chlorine species depend mainly on the pH and to a lesser extent on the concentration. Chlorine gas (Cl_2) can be formed significantly below pH 2 according to equation 3 (De Leer, 1987). Under normal conditions the pH will not drop below pH 2 during cleaning. This is only achieved when bleach is mixed with acidulous products such as toilet cleaners. To prevent this from happening, suppliers are obliged to provide hazard warnings on the package not to mix bleach with other cleaning products (Vollebregt & Van Broekhoven, 1994). Therefore it is here concluded that exposure to chlorine gas will not occur frequently.

HOCl is the predominant species between pH 2 and 7.5, whereas OCl^- is predominant in the alkaline region (see Figure 3) (AISE, 1997; Vollebregt, 1998; Racioppi *et al.*, 1994; De Leer, 1987).

$$NaOCl + H_2O \rightleftarrows HOCl + NaOH \qquad (1)$$

$$HOCl \rightleftarrows H^+ + OCl^- \qquad (2)$$

$$HOCl + H^+ + Cl^- \rightleftarrows Cl_2 + H_2O \qquad (3)$$

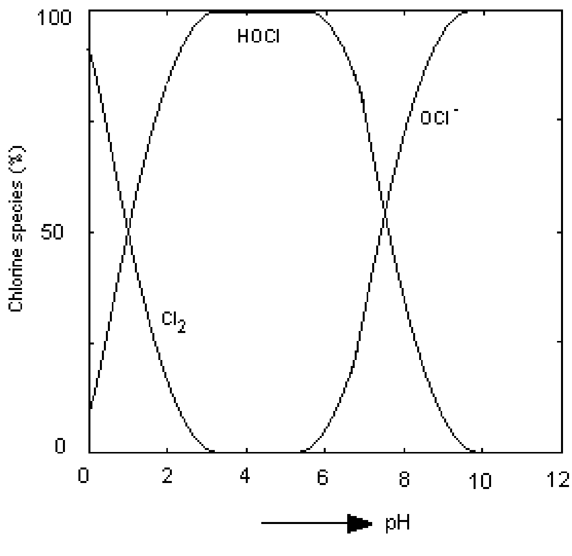


Figure 3. Chlorine species distribution diagram for chlorine species in aqueous medium (De Leer, 1987)

When products containing sodium hypochlorite are used, exposure to the compound itself will not occur. This is due to its reactivity in aqueous solutions as described above. Depending on the pH of the solution, exposure during use will be exposure to HOCl, OCl^-, or Cl_2. The pH of bleach is 10.5, of abrasive 11, and all purpose cleaner has pH 13. At these pHs, the equilibrium has shifted almost entirely to OCl^- (see Figure 3). However, after opening a bottle of bleach containing product, one smells a scent associated with chlorine. When considering that OCl^- is highly unvolatile and that ions are not associated with a scent, it is concluded that another compound evaporates from these bleach containing products. At the alkaline pHs of the products (10.5 – 13), no chlorine gas is formed (see also Figure 3). Therefore, it is concluded that this scent is caused by evaporation of small amounts of HOCl, which has a vapour pressure 10^5 higher than OCl^-. Keeping in mind the alkaline pH of the product, it is assumed that maximally 5% of the sodiumhypochlorite present in the bleach containing products, is present as HOCl.

Based on the above described, dermal and oral exposure is to OCl^- . Inhalation exposure however is assessed to HOCl. The compound characteristics of OCl^- and HOCl are listed in Table 13.

Table 13. Compound characteristics of hypochlorite ion

Parameters			Unit	Reference
Molecular formula	OCl	HOCl		
CAS number	14380-61-1	7790-92-3		
Molar weight	51.46	52.46	g/mol	
Vapour pressure	$6.6*10^{-17}$	$1.85*10^{-12}$	mm Hg	Epiwin estimate
Log K_{ow}	-3.42	-0.87	-	Epiwin estimate
Water solubility	$1*10^6$	$1*10^6$	mg/l	Epiwin estimate

4.6 Selected tasks and compounds

In chapter 3 it is described for what applications the selected products are used. From these applications one or several tasks were selected as interesting for the exposure assessments. In chapter 4, the composition of the products is outlined. Based on the hazardous properties of the compound, on its concentration in the product and on compound characteristics, compounds were selected for the assessment.

In table 14, an overview is presented of the compounds and the tasks for which exposure assessments are performed.

Table 14. Selected compounds and tasks

Product type	Selected Compound	Selected task(s)
Dishwashing liquid	Glutaraldehyde	Washing up
		Cleaning hands
Napkins	Isopropylalcohol	Cleaning kitchen working top
Spray cleaners	DDAC*	Cleaning kitchen working top
Bleach containing products	Hypochlorite ion	Cleaning kitchen sink
		Cleaning kitchen working top
	Hypochlorous acid	Cleaning kitchen floor

*DDAC: didecyl dimethyl ammoniumchloride

5 Exposure assessment

In this chapter, the exposure assessments to the selected compounds for the selected tasks are described.

5.1 Introduction

The tool used for the exposure assessments is CONSEXPO. It is especially designed for the assessment of exposure to consumer products.

5.1.1 CONSEXPO

The exposure assessments in this study are performed with the computer application CONSEXPO 3.0. CONSEXPO is developed within the framework of the project 'Consumer Risk Assessment'. It consists of a modelling approach based on mathematical contact, exposure and uptake models (see Figure 4). Contact is defined, which determines how long and how often contact to the compound is experienced when using the product for the selected task. Based on the form of the product and the way in which the product is used, suitable exposure scenarios can be selected in CONSEXPO. For each route of exposure (dermal, inhalation and oral), a number of exposure and uptake models is included (Van Veen, 1997). If no suitable scenario was available, a new model was defined within the framework of this study (i.e. oral exposure via hand-to-mouth contact and oral exposure via the intake of residues on washed dishes).
Each exposure scenario depends on several parameters. Besides these scenario specific parameters, compound characteristics that influence exposure are also necessary for the

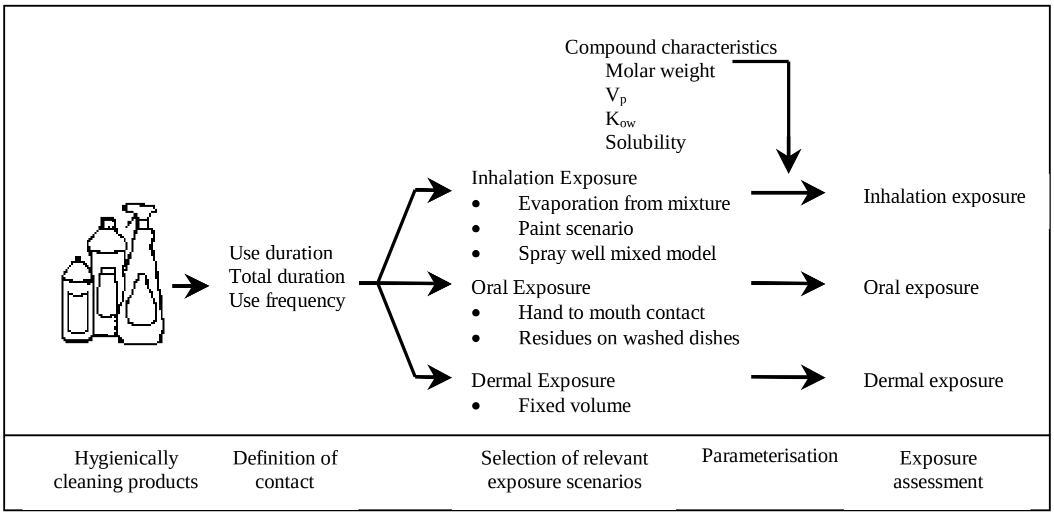


Figure 4. Schematic representation of exposure assessment with CONSEXPO 3.0

assessment. After filling in all parameters needed, CONSEXPO calculates exposure to the compound according to the selected scenario. A general overview of the used exposure models and their parameters is included as Appendix 2.

5.1.2 Method

Exposure is determined by means of point values and, if available, by using distributions that represent variability in the parameter value. The goal of the point estimates is to generate a 'reasonable worst-case scenario' around the 95-99 percentile. To reach this, the 75 or 25 percentile is used for parameters, depending on the effect of the parameter. For room volume and ventilation rate for example, the 25 percentiles were used, as a smaller room volume and a lower ventilation rate will lead to increased exposure. For the same reason, for parameters like use duration and frequency the 75 percentile was used. It was chosen not to use the maximum of the parameters, as parameters are often related to each other (e.g. frequency and duration of cleaning). This would lead to unduly conservative and unrealistic exposures (Bremmer & Van Veen, 1999).

5.2 Glutaraldehyde in dishwashing liquid

The selected tasks for the exposure estimates are washing up and cleaning hands (see also paragraph 3.1.2). As described in paragraph 4.2, exposure is assessed to the preservative glutaraldehyde, via de the use of dishwashing liquid.

During normal use, people are potentially exposed to compounds in dishwashing liquid via various routes of exposure:

- dermal exposure occurs when washing up and when cleaning hands;
- inhalation exposure to volatile components of dishwashing liquids can occur during and after washing up and washing hands;
- oral exposure can occur via the use of crockery if residues of dishwashing liquid deposit on these items (Hakkinen, 1993) and via hand-to-mouth contact when using the product.

5.2.1 Contact

Dishwashing

Without contact there is no exposure. Contact to a compound in a consumer product is defined by the frequency of use, the use duration and total duration. The process of doing the dishes with hygienic cleaning detergent, will not differ from dishwashing with 'regular' detergent. This is also emphasised in advertisements by stating that the hygienic cleaning product degreases and

cleans just as good as the regular product. It is furthermore reasonable to assume that all dishwashing is done with hygienic cleaning dishwashing liquid, as most people only use one type of dishwashing liquid at the same time.
The parameters that define contact are derived from Weegels (1997). In this study the use of dishwashing liquid was recorded in diaries by 45 subjects in 28 households for a period of three weeks. These 45 subjects reported to have done the dishes 532 times. All were selected for the determination of the use duration and use frequency. Hereby including the instances in which the dishes were done plus one or more cleaning tasks like for example cleaning the kitchen working top.
For the determination of the use frequency all instances of doing the dishes need to be included (both dishwashing only and dishwashing plus one or more cleaning tasks). The maximum frequency per person per day is 4 (2 subjects, 3 days), and the minimum frequency is 0 times per day (519 instances). The 75-percentile for the frequency of washing up is once a day (Weegels, 1997). A distribution of the frequency of dishwashing is shown in Figure 5a.

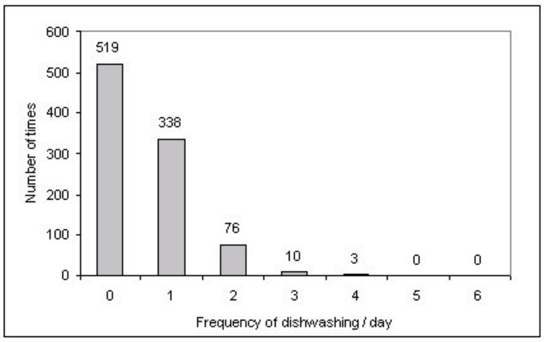
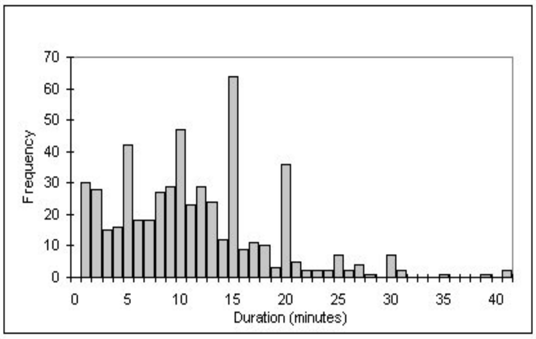


Figure 5a. Frequency of dishwashing per day



5b. Duration of dishwashing per instance

It can be argued that for the determination of the duration of dishwashing, a distinction should be made between the duration of doing the dishes only and doing the dishes plus one or more cleaning tasks. The assumption underlying this distinction is that the duration of doing the dishes and one or more cleaning tasks is longer than when doing the dishes only. To examine if this assumption is true, the duration of doing the dishes alone and doing the dishes and one or more cleaning tasks are statistically compared. The difference within a person was in only one out of ten subjects statistically significant (Student's t-test, $\alpha=0.05$), indicating that overall, there is no statistically significant difference between doing the dishes alone and together with one or more cleaning tasks. Therefore, the duration of all reported instances of doing the dishes only and doing the dishes plus one or more cleaning tasks were taken together.

The duration of dishwashing varies both within and between subjects; the minimum duration is 1 minute and the maximum duration is 60 minutes. The average duration of doing the dishes per subject ranges from 1 to 35 minutes, see figure 5b (Weegels, 1997).

In the exposure estimates, both point values and distributions for use duration and frequency are used. For the point values, the 75 percentile is used of the data derived by Weegels (1997); a

frequency of once a day and a use duration of 15 minutes. Dermal exposure ends when the soapsuds are thrown away after dishwashing. It is assumed that after washing up, the subject remains in the kitchen for another 15 minutes. Total duration for inhalation exposure to glutaraldehyde is therefore 30 minutes.
The frequency distribution (Figure 5b) of duration of dishwashing is also used in the calculation of inhalation exposure. This distribution consists of the duration of all 529 instances of dishwashing reported in Weegels' diaries are included (for 3 out of the 532 instances), duration was not reported.

Cleaning hands
When cleaning hands with dishwashing liquid, it is assumed that people do so for 1 minute. In Weegels's database cleaning hands with dishwashing liquid was reported twice, and the durations reported were both 1 minute (Weegels, 1997). The parameters that define contact are summarised in Table 15.

Table 15. Contact parameters

Scenario	Parameters		Doing the dishes	Cleaning hands	Reference
Contact	Use Frequency	(/day)	1	1	Weegels (1997)
	Use duration	(min)	15	1	Weegels (1997)
	Total duration	(min)	15 (30 for inhalation)	1	Weegels (1997)

5.2.2 Dermal exposure

Doing the dishes
When doing the dishes, dermal exposure to dilute dishwashing liquid takes place. Dermal exposure is described best with the fixed volume scenario in CONSEXPO 3.0. It describes exposure to a fixed volume of product (the dishwater) that contacts a certain area of the skin. The scenario assumes that the product is well mixed and gradients inside the product do not occur. These assumptions are applicable to dishwashing, since the liquid is well mixed before and during dishwashing.
The parameters needed in this scenario and the values used for the exposure estimate are the density of dishwashing liquid, the weight fraction of glutaraldehyde in the product, and the factor with which the product is diluted before use.

Weegels (1997) calculated the concentration of dishwashing liquid in water 24 times in different households, based on the amount of water and the amount of dishwashing liquid used. The mean volume of water is 9 l (sd 4.06, N=25), the 75 percentile is 12 l. The mean amount of dishwashing liquid used is 7.07 g (sd 5.51, N=27) and the 75 percentile is 12 g. The average concentration was 0.87 g/l (sd 0.62), the 75 percentile is 1.02 g/l (Weegels, 1997).

The density of dishwashing liquid is 1.02 g/cm^3. The weight fraction of glutaraldehyde in dishwashing liquid is 0-5% (P&G, 1998). More specifically, glutaraldehyde is added in a concentration of up to 0.1% (P&G, 1999). It is here assumed that the weight fraction equals 0.1%.

Combining the weight fraction of glutaraldehyde in dishwashing liquid and the concentration, results in an average concentration of glutaraldehyde in dishwater of 0.87 mg/kg (sd 0.62), the 75 percentile equals 1.02 mg/kg. The concentration gluataraldehyde in dishwashing liquid is 1 g/kg, the dilution factor is 1000.

The distribution of the concentration of glutaraldehyde in dishwater is visualised in Figure 6. The concentration ranges from 0.16 mg/kg to 2.72 mg/kg.

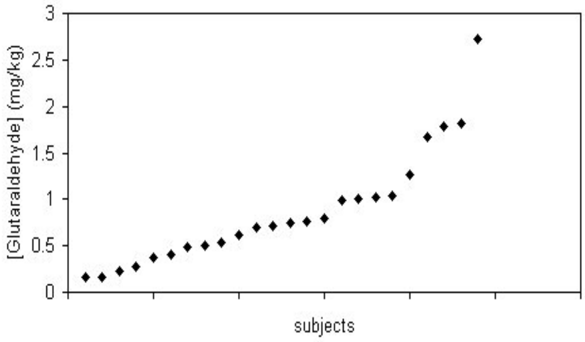


Figure 6. Concentration glutaraldehyde in soapsuds

Cleaning hands

Dermal exposure when cleaning hands is also best described with the fixed volume scenario. Here, the fixed volume to which one is exposed is the volume of (undiluted) dishwashing liquid, the volume used for cleaning hands. According to the product safety data sheet, the density of dishwashing liquid is 1.02 g/cm^3 (P&G, 1998). The weight fraction of glutaraldehyde in dishwashing liquid is 0.1% (P&G, 1999). The product is used undiluted for cleaning hands; therefore the dilution factor is set to 1. The parameters used in the exposure estimates are summarised in Table 16.

Table 16. Dermal exposure parameters

	Parameters		Washing dishes	Cleaning hands	Reference
Fixed Volume Scenario	Density of product	(g/cm^3)	1.02	1.02	P&G (1998)
	Weight fraction in product	(mg/kg)	1000	1000	P&G (1999); Weegels (1997)
	Dilution factor	-	1000[A]	1	[A]Weegels (1997)

Results dermal exposure

The point estimate based on the above-described parameters, leads to a dermal exposure concentration for dishwashing averaged over the event of 15 minutes of 1.02*10^{-3} mg/cm^3. When cleaning hands dermal exposure equals 1.02 mg/cm^3 (see also Table 17).

Table 17. Dermal exposure to glutaraldehyde calculated with CONSEXPO

		Washing Dishes	Cleaning hands
Mean event concentration	(mg/cm^3)	1.02*10^{-3}	1.02
Year average concentration	(mg/cm^3)	1.075*10^{-5}	7.17*10^{-2}

5.2.3 Inhalation exposure

Inhalation exposure to glutaraldehyde while doing the dishes takes place when this compound evaporates from the dishwater. After throwing away the soapsuds, inhalation exposure continues to the evaporated compound present in the room.
While cleaning hands people are exposed to the compound when the compound evaporates from the undiluted product.

Inhalation exposure can be described with the evaporation from mixture model. This scenario describes exposure to a compound evaporating from a mixture of other compounds. The evaporation rate is driven by the vapour pressure. It is assumed that the product is a binary mixture consisting of the chemical of interest and an averaged chemical, replacing all other chemicals. It is further more assumed that evaporation hardly influences the initial concentration of the compound in the product. Since glutaraldehyde is only slightly volatile in an aqueous solution, this scenario can be used.
The scenario is based on the following parameters: release area, temperature, room volume, effective ventilation rate, weight fraction and the molecular weight of the solvent.

Inhalation exposure during dishwashing is modelled for the user of the product, and therefore averaged over a 'personal volume' of 5 m^3 (the volume around the user's body), in a kitchen with a volume of 15m^3. This distinction between a user and a non-user is made to model the difference in exposure, resulting from the distinctive distance to the source. The effective ventilation rate is 37.5 m^3/hr. These kitchen characteristics are defaults for Dutch kitchens (Bremmer & Van Veen, 1999). The release area used is the 75 percentile of the surface of 18 sinks (see Appendix 3). The temperature is for dishwashing the temperature of the soapsuds, 45^{o}C (Falbe, 1987). The weight fraction in the product is 0.1% (P&G, 1999). The dilution factor is 1000. The product is water based, therefore its molecular weight is used as the molecular weight of the matrix.
Inhalation exposure during dishwashing is estimated based on point estimates (75 percentile) and based on the distributions for parameters.

For cleaning hands, the release area equals 930 cm^2, the surface area of the back and the palm of both hands (Bremmer & Van Veen, 1999). The temperature is the default temperature in Dutch houses, 20^{o}C (Van Veen, 1997). The room volume and ventilation rate are default values as identified by Bremmer and van Veen (1999). The weight fraction of glutaraldehyde product is 0.1% (P&G, 1999). The parameters used in the exposure estimate can be found in Table 18.

Table 18. Inhalation exposure parameters

	Parameters		Washing dishes	Cleaning hands	Reference
Evaporation from mixture	Release area	(cm^2)	1452.5	930	Appendix 3
	Temperature	(^{o}C)	45^{*}	20^{**}	*Falbe (1987), **VanVeen (1997)
	Room volume	(m^3)	15	15	Bremmer & Van Veen (1999)
	Effective ventilation rate	(m^3/hr)	37.5	37.5	Bremmer & Van Veen (1999)
	Weight fraction	(mg/kg)	1000	1000	P&G (1999)
	Dilution factor	-	1000	1	Weegels (1997)
	Molecular weight matrix	(g/mol)	18	18	Molecular weight water

Results inhalation exposure

In Table 19, the results of the CONSEXPO assessment of inhalation exposure, based upon the above-described parameters, can be found. Inhalation exposure to glutaraldehyde averaged over the total duration of washing up (30 minutes), is $7.9*10^{-7}$ mg/m^3. The average inhalation exposure when cleaning hands is $3.87*10^{-5}$ mg/m^3.

Table 19. Inhalation exposure to glutaraldehyde calculated with CONSEXPO

		Washing dishes	Cleaning hands
Mean event concentration	(mg/m^3)	$7.9*10^{-7}$	$3.87*10^{-5}$
Year average concentration	(mg/m^3)	$1.67*10^{-8}$	$2.72*10^{-8}$

In Figure 7, inhalation exposure is plotted against time. During the first 15 minutes, exposure increases. At t=15, the soapsuds is thrown away. Hereafter, exposure decreases as a result of ventilation.

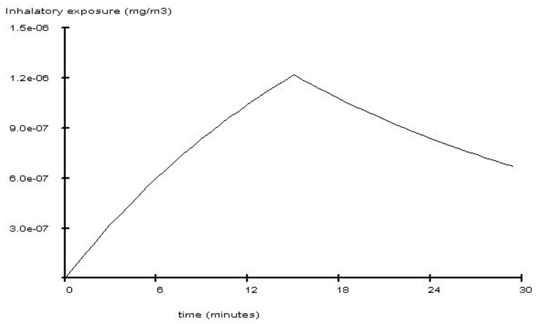


Figure 7. Inhalation exposure during dishwashing

For dishwashing, the variability in various parameters is expressed in the results by means of a Monte Carlo analysis. At random, 10,000 tries are done from the input distributions, resulting in a frequency distribution of exposure. The distributions entered are for:

- use duration: the duration of each of 529 instances reported in the diaries (Weegels, 1997);
- weight fraction x dilution: as described in dermal exposure (see Figure 6);
- release area: variation in release area of 18 sinks (see appendix 3).

The resulting distribution of exposure is shown in Figure 8. Inhalation exposure during use ranges from $2.3*10^{-7}$ to $2.5*10^{-6}$ mg/m^3. From this figure it can be concluded that even in the 'high' exposure range, inhalation exposure to glutaraldehyde during dishwashing is still low.

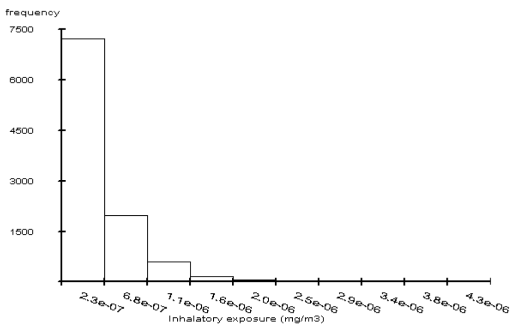


Figure 8. Frequency distribution of inhalation exposure

5.2.4 Oral exposure

Oral exposure to components of dishwashing liquid such as glutaraldehyde can occur via two routes of exposure. During dishwashing via hand-to-mouth contact, and after dishwashing via residues that remain on washed items such as dishes and glassware. Oral exposure due to hand to mouth contact when cleaning the hands is considered negligible due to the low use duration.

Hand to mouth contact while doing the dishes
It is assumed that oral exposure during hand-to-mouth contact takes place by taking in 5 times the amount of glutaraldehyde attached to 1 square centimetre of the hand (a fingertip), when washing up for a duration of 15 minutes, once a day.

To examine the amount of water attached to a square centimetre of the hand, a pilot study was done. It was examined how much water would attach to the hand if it was immersed wrist deep in water. This study is described in more detail in Appendix 4. The amount of water attached to the surface of the female hand was 2.9 g, the amount attached to the male hand equals 4.2 g (75 percentile). The default surface area of the hand is for women 430 cm^2 and 490 cm^2 for men (Bremmer & Van Veen, 1999). The amount of glutaraldehyde on one square centimeter of the hand is $6.9*10^{-6}$ mg for women and $8.7*10^{-6}$ for men (see Table 20).

Table 20. The amount of glutaraldehyde attaching to 1 cm^2 of the hand during doing the dishes

	Water attached to hand (mg)	Surface area of hand (cm^2)*	Wf	Glutaraldehyde/cm^2 (mg/cm^2)
Female	$2.9*10^3$	430	$1.02*10^{-6}$	$6.9*10^{-6}$
Male	$4.2*10^3$	490	$1.02*10^{-6}$	$8.7*10^{-6}$

*Reference: Bremmer & Van Veen (1999)

When taking in the amount attached to 1 square centimetre of the hand 5 times, oral exposure is $3.5*10^{-5}$ mg/day based on the data of the female hand, and $4.4*10^{-5}$ mg/day based on male hand data.

Dishes and glassware
Only little information is available of residuals of dishwashing liquid on washed dinnerware. Hakkinen (1993) mentions this as a potential route of exposure. However, no quantitative information is available in literature on the amount of detergent remaining on washed dishes. Hakkinen (1999) reports in a personal communication, that in a report by Kerstholt and Van der Heide on 'Quantitative determination of anionics residues on dishes' it is stated that the anionics residue on porcelain dishes ranges from 1 to 8 mg/m^2. This quantity depends on the detergent concentration, the washing-up temperature and whether or not the dishes are dried. The residue amount goes up as the detergent concentrations in the dishwater go up and as the dishwater temperature goes up. When crockery is not dried, more detergent is left behind on it (Hakkinen, 1999).

When considering that the weight fraction of anionics in dishwashing liquid is higher than the amount glutaraldehyde (15-30% vs. 0.1%), it is concluded that the remainders of glutaraldehyde

on washed crockery are at least a factor 10 lower than 1-8 mg/m^2; maximally 0.1-0.8 mg/m^2.
It is here assumed that the amount of glutaraldehyde residing on 1 m^2 crockery is taken in per day. Which results in oral exposure to 0.8 mg/day.

Results oral exposure
Total oral exposure to glutaraldehyde resulting from hand to mouth contact and from residues on crockery is 0.8 mg/day.

5.3 Isopropylalcohol in napkins

The active ingredient in hygienic cleaning napkins is isopropylalcohol. In paragraph 3.2, the task selected for the exposure assessment is cleaning the kitchen working top. The compound to which exposure is assessed is isopropylalcohol (see also paragraph 4.3).

When using napkins to clean a surface people are exposed via the dermal route. Isopropylalcohol is a volatile compound and therefore there is also exposure via inhalation. Potentially, oral exposure can occur by hand-to-mouth contact.

5.3.1 Contact

No information is available in literature on the use of the product, because the product is newly introduced on the market, and no other cleaning product in the form of napkins exists. It is here assumed that the napkins are used once a day for a period of 3 minutes for cleaning the kitchen working-top. This is based on the duration of cleaning the kitchen working top with other products as reported in diaries (Weegels, 1997). For dishwashing liquid, the following durations are found 1, 2, 3 and 5 minutes. For cleaning with all purpose cleaner durations of 4, 5, 5 and 6 minutes were found. The reported duration of cleaning the kitchen working top with abrasive is 5 and 2 minutes. After use of the napkins it is not necessary to rinse the surface, therefore the duration is considered to be less than that of cleaning with all-purpose cleaner of abrasive.

The duration of dermal exposure is thus 3 minutes. After use of the product, the napkin is thrown away and dermal exposure will end. For inhalation exposure, it is assumed that after disposing the napkins, the person remains in the kitchen for another 7 minutes. Total duration for inhalation exposure is therefore 10 minutes of which the use duration is 3 minutes. The parameters that define contact are summarised in Table 21.

Table 21. Contact parameters

	Parameters		Cleaning kitchen working top	Reference
Contact Definition	Use Frequency	(/ day)	1	Estimate
	Use duration	(min)	3	Estimate
	Total duration	(min)	3 (10 for inhalation)	Estimate
	Start	(min)	0	Estimate

5.3.2 Dermal exposure

The scenario best suitable for the description of dermal exposure to hygienic cleaning napkins in CONSEXPO 3.0 is the fixed volume scenario. It describes exposure to a certain amount of product that contacts a certain area of the skin. The scenario assumes that the product is well mixed and that gradients inside the product do not occur. Moreover it is assumed in this scenario that the concentration the subject is exposed to, does not change during contact. Isopropylalcohol is a volatile compound. The assumption that the concentration throughout contact equals the initial concentration leads to a worst-case estimate. Since there is no dermal exposure scenario that does take into account the change in concentration, the fixed volume scenario was used.

The parameters necessary for the exposure assessment are: density of the product, the weight fraction of isopropylalcohol in the hygienic cleaning napkins, and the dilution factor. They are summarised in Table 22. It is assumed that the product is water based, thus the density of the liquid phase of the product is assumed to be 1 kg/l. The weight fraction of isopropylalcohol in the napkins is, according to the product safety data sheet, 1-5% (Lever, 1998). It is here assumed that the percentage equals 5%.
As mentioned before, the product is ready for use when taken from the box. Therefore, the dilution factor equals 1.

Table 22. Dermal exposure parameters

	Parameters		Cleaning kitchen working top	Reference
Fixed Volume Scenario	Density of product	(kg/l)	1	Estimate
	Weight fraction	(%)	5	Lever (1998)
	Dilution factor	-	1	Product label

Results Dermal Exposure
In Table 23, the results of the calculation of dermal exposure are outlined. The concentration isoproplylalcohol to which a user is exposed equals 50 mg/cm^3. In real, the mean event concentration is lower than 50 mg/cm^3 due to evaporation of the compound during use.

Table 23. Dermal exposure to isopropylalcohol calculated with CONSEXPO

		Exposure
Mean event concentration	(mg/cm^3)	50
Year average concentration	(mg/cm^3)	10.54

5.3.3 Inhalation exposure

In CONSEXPO 3.0, there are two scenarios suitable for the assessment of inhalation exposure during cleaning: the evaporation from mixture and paint scenario. The striking difference between both models is that the first assumes that the concentration of the compound of interest in the original product is not influenced by evaporation, whereas the paint scenario does take a decrease in concentration due to evaporation into account.
A quick scan of the suitability of the evaporation from mixture model was done. The derivation of the amount of cleaning product in the napkins is described in Appendix 1, and equals 3.42 g. The small amount isopropyl alcohol present in the napkins (5%*3.42 = 0.171 g), and the volatility of isopropylalchol (33 mm Hg) result in a maximum possible concentration of 11.4 mg/m^3 that can be reached in a room of $15m^3$ without ventilation. The evaporation from mixture scenario leads to a concentration of 795 mg/m^3 in a room of $15m^3$. These results indicate that the evaporation from mixture scenario is unsuitable for calculation of inhalation exposure in this

situation. Therefore, the paint scenario was used.

Inhalation exposure can be calculated for both a user and a non-user. For the non-user exposure is averaged over the whole room volume. For the user, exposure is averaged over a personal air volume of $5m^3$ around his or her body. This distinction is made in order to take into account the different distance to the source between a user and a non-user. The user is exposed closer to the source, therefore the user will experience a more intense exposure before the compound has spread over the entire room.

Based on the floor plan of two kitchens of 5.9 m^2, the release area of the kitchen working top was determined. It equals 17148 cm^2. The determination of the release areas is described in Appendix 3. The amount of product is determined by weighting five napkins when taken directly from the package and again after overnight drying in the stove at a temperature of 100°C (see Appendix 1). The 75th percentile was used. The weight fraction of isopropylalcohol is 1-5% according to the product safety data sheet. Here, a weight fraction of 5% was used in the exposure estimate. It is assumed that the liquid phase is water based, and that density of the wet fraction of the product equals 1 kg/l. When cleaning, there is only one layer. Therefore the fraction of the upper layer is set to 99.99%. Because there is only one layer, the layer exchange rate does not influence exposure. The room volume and the effective ventilation rates are default values for Dutch kitchens, $15m^3$ and $37.5m^3$/hour as determined by Bremmer & Van Veen (1999). The default temperature in Dutch homes is 293 K (Van Veen, 1997). As it is assumed that the wet fraction of the product is water based, the molecular weight of the matrix equals 18 g/mol. The parameters needed for the calculation of inhalation exposure are summarised in Table 24.

Table 24. Inhalation exposure parameters

	Parameters		Cleaning	Reference
Contact Definition	Use Frequency	(/day)	1	Estimate
	Use duration	(min)	3	Estimate
	Total duration	(min)	10	Estimate
	Start	(min)	0	
Paint scenario	Release area	(cm^2)	17148	Estimate[1]
	Product amount	(g)	3.42	Weighted[2]
	Weight fraction	(%)	5	SDS
	Density product	(kg/l)	1	Etimate
	Layer exchange rate	(/minute)		[3]
	Fraction to upper layer	(%)	99.99	Estimate
	Room volume	(m^3)	15	Bremmer & Van Veen (1999)
	Effective ventilation	(m^3/hr)	37.5	Bremmer & Van Veen (1999)
	Temperature	(K)	293	Van Veen (1997)
	Molecular weight solvent	(g/mol)	18	Estimate

[1]Estimate described in appendix 3: release areas
[2]Estimate described in appendix 1: amount used of napkins
[3]Does not influence exposure assessment since there is only one layer.

Results Inhalation exposure

Inhalation exposure calculated with CONSEXPO 3.0 for a user based on the above-described parameters, results in inhalation exposure to isopropylalcohol of 23.3 mg/m^3 averaged over the total duration of 10 minutes (see Table 25).

Table 25. Inhalation exposure to isopropylalcohol calculated with CONSEXPO

		Exposure
Mean event concentration (non-user)	(mg/m^3)	7.860
Mean event concentration (user)	(mg/m^3)	$2.33*10^1$
Year average concentration	(mg/m^3)	$5.523*10^{-2}$
Year average concentration (user)	(mg/m^3)	$1.639*10^{-1}$

In Figure 9 exposure for the user is plotted against time. During the first 3 minutes the concentration in the room increases due to evaporation. At t=3 minutes, the napkin is disposed of, and the concentration in the room decreases as a result of ventilation.

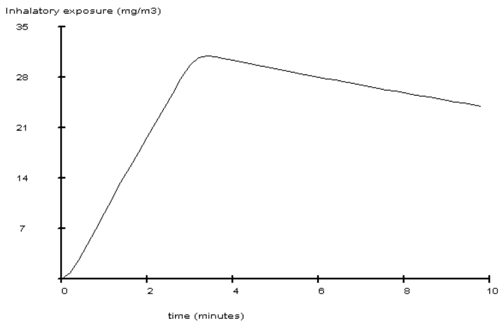


Figure 9. Inhalation exposure to isopropylalcohol when cleaning the kitchen working top

5.3.4 Oral Exposure

A potential route of oral exposure is exposure via hand to mouth contact, when people are using the product to clean and when they touch their lips. It is assumed that during cleaning the kitchen working top (duration 3 minutes), the user is orally exposed to the amount attached to 1 cm^2 of the hand 3 times.

It was thus studied how much product will stick to the hand palm. When firmly touching the napkin, as one would do when using the product to clean, 0.044 g remains on the surface area of the hand palm (sd 0.004, N=5). The weight fraction isopropylalcohol in the product is 5%. This indicates that the maximum amount isopropylalcohol on the entire hand palm equals 2.2 mg. The default surface area for the back and palm of both female hands equals 860 cm^2 (Bremmer & Van Veen, 1999). The surface area of the palm of the hand is approximately $1/4^{th}$ or 215 cm^2.
The amount isopropyl alcohol per square centimetre is thus 0.01 mg. During the cleaning event, an amount of 0.03 mg is taken up orally. However, it should be taken into account that isopropylalchohol is a volatile compound. This implies that due to vaporisation the actual amount taken in is smaller than 0.03 mg.

5.4 DDAC in spray cleaners

In this paragraph, exposure to DDAC, (the compound selected in paragraph 4.4) is assessed. This is the ingredient found in the disinfecting spray cleaner. The task selected for the assessment in paragraph 3.3 is cleaning the kitchen working top.

Exposure to compounds in hygienic cleaning spray cleaners can occur via various routes of exposure. The product is applied by spraying. During spraying, inhalation exposure can take place when droplets of the product are inhaled or when the compound of interest evaporates from the droplets. When leaving the product to soak in, and during cleaning, inhalation exposure occurs as a result of evaporation from the product sprayed on the kitchen working top. Dermal contact can take place when wiping the surface, to remove the product. Potentially, oral exposure can occur via hand-to-mouth contact.

The various phases (spraying, leaving on and cleaning) are addressed separately in the exposure estimate, because of the difference in contact and use in these phases.

The use of hygienic cleaning trigger sprays or products that are used likewise is not described in literature. The parameters that define contact are use frequency, total duration and use duration. To gain some more insight into the use of these products, a small-scale pilot study was done. The methods and results of this pilot are described in Appendix 5.

5.4.1 Contact

In the pilot study, the use of these products was studied in a test situation. Therefore, it was impossible to derive the use frequency from these data. It is assumed that the kitchen working top is cleaned once a day with the DDAC containing trigger spray.
Use duration was extrapolated linearly from the pilot. The assumption underlying this extrapolation is that the duration of the phases spraying and rinsing/cleaning is directly related to the size of the cleaned area. The phase of leaving the product to soak is naturally independent of the size of the area to be cleaned.
The size used here for the kitchen working top is 17148 cm^2 (see appendix 3). The area cleaned in the pilot was 60x60cm. The size of the kitchen working top is 4.76 times larger the area cleaned in the pilot. The 75 percentile of the duration of the spraying and rinsing/cleaning phase (5 respectively 17 seconds) are therefore multiplied with the factor 4.76.

Table 26. Contact during spraying, leaving on and rinsing/cleaning

	Parameters	Spraying (phase 1)	Leaving on (phase 2)	Rinsing/cleaning (phase 3)	Reference
Contact	Use frequency	1 / day	1 / day	1 / day	Estimate
	Use duration	24 sec	5 min	81 sec	Appendix 5

5.4.2 Dermal exposure

Dermal exposure occurs when wiping or cleaning the surface with a cloth after the product was left to soak in for a while. The duration of this phase is 81 seconds. The fixed volume scenario is best suitable for a description of dermal exposure to DDAC with CONSEXPO. It describes exposure to a certain amount of product with a constant concentration. The parameters for the exposure assessment are summarised in Table 27. The density of the product is measured and equals 1 g/cm^3. The dilution factor is set to 1, because the product is used undiluted.

Table 27. Dermal exposure parameters

	Parameters		Reference
Fixed volume scenario	Density of product (g/cm^3)	1	Estimate
	Weight fraction (g/kg)	2	Label SanaSept
	Dilution factor	1	Undiluted use

Results

In Table 28, the results of the dermal exposure assessment to DDAC are described. Exposure to undiluted product results in a dermal exposure of 2 mg/cm^3 averaged over 81 seconds. It is expected that most people will use a wet cloth for cleaning the surface area and therefore will be exposed to lower concentrations DDAC. However, since it was observed in the pilot (see Appendix 5) that 2 out of 5 people used a dry cloth for cleaning and 1 out of 5 kitchen paper, contact to undiluted product when cleaning the surface is possible.

Table 28. Dermal exposure to DDAC calculated with CONSEXPO

	Exposure
Mean event concentration (mg/cm^3)	2
Year average concentration (mg/cm^3)	1.895×10^{-3}

5.4.3 Inhalation exposure

The scenarios used for modelling inhalation exposure to DDAC when using a trigger spray differ among the various use phases. For spraying, the first phase, the model best applicable is the spray well mixed model. The spray cloud model would theoretically fit exposure best. The assumption that the user has his nose in the cloud however, overestimates inhalation exposure extremely. In real, a user uses the product approximately an arm-length away from his face. Due to this assumption, the spray well mixed scenario models inhalation exposure better, although it assumes that the airborne fraction of the product immediately fills the room (non-user scenario) or the personal volume (user scenario). In case of the user scenario, the volume of air over which exposure is calculated exposed is 5m^3, the volume around the body. To approximate the cloud, the user scenario was used. Inhalation exposure during the leaving on phase and the rinsing/cleaning phase is best described with the evaporation from mixture scenario. This scenario describes exposure to a compound that evaporates from a mixture of other compounds. Here, the assumption that evaporation of the compound does not decrease the concentration in the products is appropriate since DDAC is only slightly volatile.

Spraying

The parameters needed for the exposure estimate with the spraying well-mixed model are listed in Table 29 together with the chosen values. The generation rate is the 75 percentile of the generation rates for SanaSept as deduced from the amount used and the duration of spraying as found in the pilot study (see Appendix 5). The airborne fraction is low, since the product is sprayed close to the surface (10 cm). The airborne fraction is set to 10%. It is difficult to estimate the droplet size. Here, the droplet size for a large droplet (20 μm) was used (Matoba, 1998).

Table 29. Inhalation exposure parameters during spraying

	Parameters			Reference
Contact Definition	Use frequency	(/day)	1	Estimate
	Use duration	(sec)	24	Pilot
	Total duration	(sec)	405	Pilot (three phases together)
	Start	(sec)	0	
Spraying Well Mixed Model	Generation rate	(mg/min)	964	75th percentile of Pilot
	Density of the formulation	(kg/l)	1	Density of water
	Weight fraction	(g/kg)	2	CTB (1996)
	Airborne fraction	-	0.1	Estimate
	Effective ventilation	(m^3/hr)	37.5	Bremmer&Van Veen (1999)
	Room volume	(m^3)	15	Bremmer&Van Veen (1999)
	Droplet size	(μm)	20	Matoba (1998)
	Release height	(cm)	10	Pilot

Results inhalation exposure during spraying

Inhalation exposure during spraying is calculated with CONSEXPO based on the above described parameters. It is averaged over the event, $3.157*10^{-4}$ (see Table 30).

The airborne fraction and droplet size are uncertain parameters. To examine the effect of these parameters on inhalation exposure, sensitivity analyses were done. The analysis for the airborne fraction indicates that a fraction of 70% results in an increased exposure with a factor 7 ($2.21*10^{-3}$ mg/m^3) compared to 10%. In the sensitivity analysis performed to study the effect of droplet size on inhalation exposure, it was found that a difference in droplet size ranging from 5 (size of a small droplet according to Matoba (1998)) to 40 μm, results in a difference in exposure of $4.5*10^{-3}$ mg/m^3 to practically zero.

Table 30. Inhalation exposure to DDAC during spraying calculated with CONSEXPO

		Exposure
Mean event concentration user	(mg/m^3)	$3.157*10^{-4}$

Leaving on & cleaning

Inhalation exposure during leaving on and rinsing/cleaning (phases 2 and 3) occurs when the compound of interest evaporates from the product spayed on the surface. The duration of contact is here 5 minutes and 81 seconds.

The parameters and the values used to describe exposure according to this exposure scenario are listed in Table 31. Exposure starts after the spraying phase, after 24 seconds. The release area for the kitchen working top is 17148 cm^2, for a description of the determination of this release area see appendix 3.

The default room temperature is 293K (Van Veen, 1997). The room volume and the effective ventilation rate are the default values for Dutch kitchens (Bremmer &Van Veen, 1999). Assuming the product is water based, the molar weight of the matrix is set to 18 g/mol. Inhalation exposure is $1.87*10^{-6}$ mg/m^3 averaged over the two phases (leaving on and cleaning).

Table 31. Inhalation exposure parameters during leaving on & cleaning

	Parameters			Reference
Contact	Use frequency	(/day)	1	Estimate
	Use duration	(sec)	381	Pilot
	Total duration	(sec)	405	Pilot
	Start	(sec)	24	End of phase 1
Evaporation From mixture	Release area	(cm^2)	17148	Appendix 3
	Temperature	(K)	293	Default Van Veen (1997)
	Room volume	(m^3)	15	Default Bremmer&Van Veen (1999)
	Effective ventilation rate	(m^3/hr)	37.5	Default Bremmer&Van Veen (1999)
	Weight fraction	(g/kg)	2	Label SanaSept
	Molar weight solvent	(g/mol)	18	Molar weight water

Results inhalation exposure during leaving on and cleaning
Inhalation exposure during leaving on and cleaning is $1.876*10^{-6}$ mg/m^3 averaged over the duration of these phases, see Table 32.

Table 32. Inhalation exposure to DDAC during leaving on and cleaning calculated with CONSEXPO

		Exposure
Mean event concentration	(mg/m^3)	$1.876*10^{-6}$

Results total inhalation exposure
In Figure 10a and b, the inhalation exposure is plotted against time. In Figure 10a exposure during spraying is plotted against time. The first 24 seconds (during spraying) inhalation exposure increases. After 24 seconds the droplets deposit on the surface, decreasing exposure. In Figure 10b, inhalation exposure is plotted during the second and the third phase, while leaving the product to soak in and when cleaning the surface.

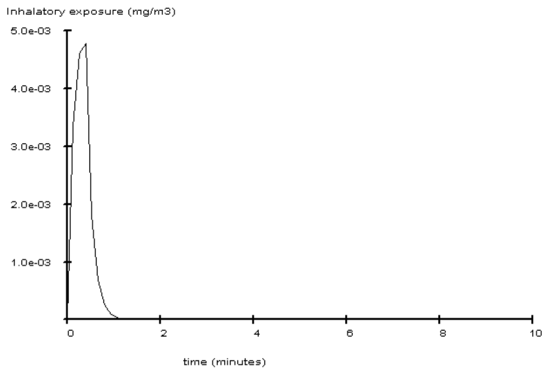
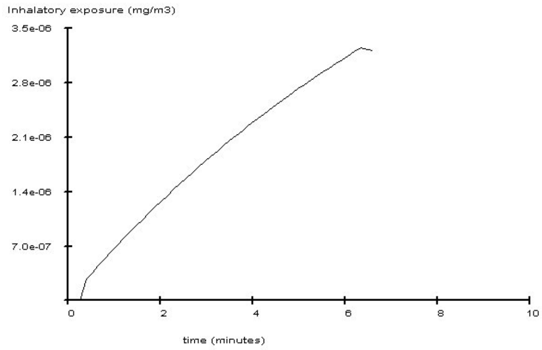


Figure 10a. Inhalation exposure during phase 1 (spraying)



10b. Inhalation exposure during phase 2 and 3 (leaving on and cleaning).

Total inhalation exposure can be calculated by adding both inhalation exposures. This results in a mean event concentration of $3.18*10^{-4}$ mg/m^3 (see Table 33).

Table 33. Total inhalation exposure to DDAC when cleaning the kitchen working top

	Inhalation exposure 1 (mg/m^3)	Inhalation exposure 2 & 3 (mg/m^3)	Mean event concentration (mg/m^3)
Inhalation exposure	$3.16*10^{-4}$	$1.87*10^{-6}$	$3.18*10^{-4}$

5.4.4 Oral exposure

During the event of cleaning the kitchen working top, people are orally exposed via hand-to-mouth contact when they are cleaning the surface (phase 3). The duration of cleaning is 81 seconds. It is assumed that during these 81 seconds people will take in the amount attached to a square centimeter of the skin 2 times.

The amount of water attached to a hand (palm and back together) is for men 8.5 mg/cm^2 and for women 6.7 mg/cm^2 (see Appendix 4). The weight fraction DDAC in hygienic cleaning sprays is $2*10^{-3}$ (or 2 g/l). This implies that the amount DDAC on a square centimetre of the hand equals 0.016 mg for men and 0.013 mg for women. When this amount is taken in 2 times during this phase, oral exposure for men equals 0.032 mg/instance and for women 0.026 mg/instance.

5.5 Sodiumhypochlorite in bleach containing products

The bleach containing products that belong to the category hygienic cleaning products used in the kitchen are bleach, bleach containing abrasive and all-purpose cleaner. All of these products contain sodiumhypochlite (bleach) in a concentration up to 5% (specified on the product safety data sheet as 1-5% or <5%). They are discussed here together because in this study exposure is assessed to the hypochlorite ion (dermal and oral exposure) and hypochlorous acid (inhalation exposure). Both are products when sodiumhypochlorite is dissolved in water (see also paragraph 4.5.1).
In the product, almost all sodiumhypochlorite will be present as hypochlorite ion because of the alkaline pH of the products (10.5 – 13). It is assumed that dermal exposure principally occurs to hypochlorite ion (OCl^-). Because oral exposure only occurs due to hand-to-mouth contact, and is thus related to dermal exposure, oral exposure is also assessed to OCl^-. OCl^- is hardly volatile since it is an ion, but as a scent is smelled when opening a bottle of bleach containing product, it is concluded that the compound evaporating from the product is hypochlorous acid (HOCl). Therefore, inhalation exposure is assessed to HOCl. Due to the alkaline pH of the products, this compound is only present in a small percentage of the total concentration of sodiumhypochlorite; it is here assumed as 5% (see also paragraph 4.5.1).
In paragraph 3.4 it is described that the tasks selected for the exposure assessments are cleaning the kitchen working top and sink with undiluted product and cleaning the kitchen floor with diluted product.

5.5.1 Exposure when cleaning the sink and the kitchen working top

5.5.1.1 Contact

Frequency of cleaning the kitchen working top and sink

From the diaries in Weegels's study, it is concluded that bleach is not used very regularly in the kitchen. In the three week period, the product was used three times by two subjects (Weegels, 1997).
In Figure 11, a frequency distribution is presented of how many times a week people reported to clean their kitchen working-top. Most people (73.6%) clean their kitchen working-top 7 times a week or more (Consumentenbond, 1998). In Table 34 it is described how often people use a bleach containing product to clean their kitchen working top (Consumentenbond, 1998).

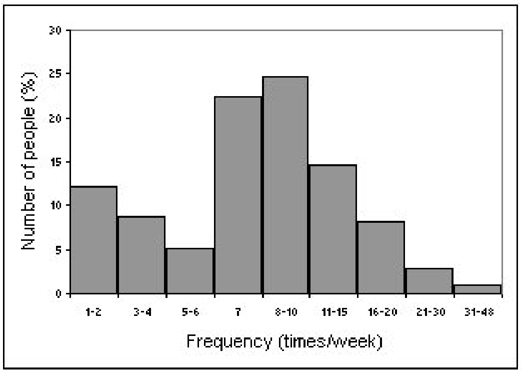


Figure 11. Frequency of cleaning the working top

Table 34. Frequency of cleaning the kitchen working top with bleach containing products

	Number of people that reports to use product	% subjects that reports to use product	Frequency of cleaning the kitchen working top		
			Less than once a week	Once a week	More than once a week
Abrasive	127 of 652*	20%	6.9%	9%	4.1%
Bleach	120 of 706*	17%	9%	6.5%	1.5%
All purpose cleaner	36 of 629*	5.5%	2%	2.5%	1%
Total	283	42.5%	17.9%	18%	6.6%

*number of subjects that reported to use the product of total number of subjects that answered the question

From figure 11 and Table 34 the following is concluded. Most people clean their kitchen working top 7 times a week or more. Approximately 43% uses a bleach containing product for cleaning the kitchen working top. Of these people, approximately 50% (18% of the total number of subjects that answer the question) reports to use the product once a week.

The main property, the bleaching of stains and the association with hygienic cleaning of the bleach containing products are very much alike. It is therefore expected that if people use one of these products, they will not use the other two for the same task. It is here assumed that people clean the sink and the kitchen working-top equally frequent with bleach containing products. If people clean their kitchen working-top with a bleach-containing product, they will clean their sink subsequently.

The use frequency of using a bleach containing product to clean the kitchen working top and sink, selected for the exposure assessment is once a week, based on the displayed information.

Use duration

Only little information is available on the duration of cleaning the kitchen working top and sink with bleach containing products. The following use durations are reported in diaries. The duration of cleaning the kitchen working top with bleach is reported twice, with a duration of 8 (both kitchen working top and sink) and 10 minutes (kitchen working top). The duration of cleaning the kitchen sink was derived from the durations reported for abrasive; in one instance 1 minute, four instances 3 minutes and 2 instances 5 minutes (Weegels, 1997).
The available information is not sufficient to determine with certainty how long it takes people to clean their kitchen working-top with bleach containing products. However, it is assumed that the duration of cleaning a sink is 5 minutes. The duration for cleaning the kitchen working top is expected to be longer, (due to its larger surface area) it is assumed that it takes 10 minutes.

It is further more expected that after cleaning with bleach, the sink and the working top are rinsed with water (also considering the capacity of bleach to cause stains in clothes); indicating that exposure ends at this moment in time. This implies equal use and total duration. The parameters that define contact are summarised in Table 35.

Table 35. Contact parameters

	Parameters		Sink	Kitchen working top	Reference
Contact Definition	Frequency	(/week)	1	1	Consumentenbond (1998)
	Use duration	(min)	5	10	Estimate, Weegels (1997)
	Total duration	(min)	5	10	Estimate, Weegels (1997)

5.5.1.2 Dermal Exposure

Abrasive is always used undiluted with a little water (use instructions). All-purpose cleaner and bleach can be used both undiluted and diluted according to the packages. It is person specific and it depends on the task, whether people use the product diluted or not. It is here assumed that the kitchen working-top and the sink are cleaned with undiluted product. If the product is used undiluted, dermal exposure to OCl^- occurs mainly via the cloth or sponge that is used to clean the surface.

The scenario in CONSEXPO 3.0 best fit to model dermal exposure is the fixed volume model. It describes exposure to a fixed volume of product that contacts a certain area of the skin. The scenario assumes that the product is well mixed and that gradients inside the product do not occur.

The density of the products differs among the various products, therefore for each product dermal exposure was determined separately. The weight fraction for all products is 5% and the products are used undiluted for this task, which implies a dilution factor of 1.

Table 36. Dermal exposure parameters

	Parameters		Bleach	Abrasive	All purpose cleaner	Reference
Fixed volume scenario	Density of product	(kg/l)	1.1[a]	1.5[b]	1.04[c]	[a]Lever (1993), [b]Grada (1998), [c]Colgate Palmolive (1995)
	Weight fraction	(%)	5[a]	5[b]	5[c]	[a]Lever (1993), [b]Grada (1998), [c]Colgate Palmolive (1995)
	Dilution factor	-	1	1	1	Undiluted use

Results dermal exposure

Dermal exposure to the hypochlorite ion when using a bleach containing product for cleaning the kitchen working top or the kitchen sink ranges from 52 mg/cm^3 (for all purpose cleaner) to 75 mg/m^3 (for abrasive). The differing density of the products causes the difference in exposure. These results can be found in Table 37.

Table 37. Dermal exposure to hypochlorite ion calculated with CONSEXPO 3.0

		Bleach	Abrasive	All purpose cleaner
Mean event concentration	(mg/cm^3)	55	75	52
Year average concentration sink*	(mg/cm^3)	$2.761*10^{-2}$	$3.765*10^{-2}$	$2.61*10^{-2}$
Year average concentration kitchen working top*	(mg/cm^3)	$5.521*10^{-2}$	$7.529*10^{-2}$	$5.22*10^{-2}$

*Difference in year average concentration is caused by differing use duration

5.5.1.3 Inhalation exposure

Inhalation exposure when using sodiumhypochlorite bleaches occurs to hypochlorous acid. It can be assessed by means of the evaporation from mixture scenario in CONSEXPO. This scenario describes inhalation exposure to a compound that evaporates from a product. The most important assumption in this scenario is that the concentration in the product does not decrease during use. Because hypochlorous acid is hardly volatile, this assumption is justified. The parameters needed to describe exposure are release area, temperature, room volume, the effective ventilation rate and the molecular weight of the matrix. The release areas for the kitchen sink and the kitchen working top are described in appendix 3. They equal 3900 and 17148 cm^2 respectively. The default value for room temperature is 20°C (Van Veen, 1997). The room volume and the effective ventilation rate are 15 m^3 and 37.5 m^3/hr, the default values for Dutch kitchens (Bremmer & VanVeen, 1999). The weight fraction of HOCl in bleach containing products is assumed to be 0.05 of the total weight fraction of 0.05 sodiumhypochlorite in the product. The weight fraction of HOCl is thus 0.025. The products are water based, therefore, the molecular weight of the matrix is set to that of water, 18 g/mol. The parameters are listed in Table 38.
The parameters that differ for cleaning the kitchen sink and the working top are the contact parameter, use duration; and the evaporation from mixture scenario parameter, release area**.**

Table 38. Inhalation exposure parameters

	Parameter		Sink	Working top	Reference
Evaporation from mixture	Release area	(cm^2)	3900.5[1]	17148[2]	Appendix 3
	Temperature	(K)	293	293	Van Veen (1997)
	Room volume	(m^3)	15	15	Bremmer & Van Veen (1999)
	Effective ventilation rate	(m^3/hr)	37.5	37.5	Bremmer & Van Veen (1999)
	Weight fraction	(fraction)	$2.5*10^{-3}$	$2.5*10^{-3}$	Estimate
	Molecular weight of the solvent	(g/mol)	18	18	Molecular weight water

Results inhalation exposure

In Table 39, the results of the inhalation exposure assessment are described. Inhalation exposure to hypochlorous acid based on the evaporation from mixture scenario and the above described parameters equals $2.79*10^{-13}$ mg/m^3 when cleaning the kitchen sink and $4.55*10^{-12}$ mg/m^3 when cleaning the kitchen working top.

Tabel 39 Inhalation exposure to hypochlorous acid calculated with CONSEXPO

		Sink	Working top
Mean event concentration	(mg/m^3)	$2.785*10^{-13}$	$4.55*10^{-12}$
Year average exposure	(mg/m^3)	$1.398*10^{-16}$	$4.57*10^{-15}$

5.5.2 Exposure to bleach when cleaning the kitchen floor

Dermal and inhalation exposure are relevant routes when cleaning the kitchen floor. A potential route of exposure is exposure due to hand-to-mouth contact.
Dermal and oral exposure to hypochlorite ion is assessed when cleaning the kitchen floor with diluted bleach containing all purpose cleaner. Inhalation exposure is assessed to hypochlorous acid.

5.5.2.1 Contact

The frequency of cleaning the kitchen floor is again, difficult to derive from literature. It is assumed that if people clean the kitchen floor with all-purpose cleaner, they do so once a week. The duration of cleaning the kitchen floor is difficult to derive from the data gathered by Weegels (1997). Often people either clean more floors subsequently or clean other things in the kitchen as well (Weegels, 1997). Nevertheless, in the diaries four people have reported to clean the kitchen floor. The durations reported are 10, 12, 17 and 55 minutes. In the exposure estimate, a use duration of 15 minutes is used. The duration of 55 minutes is expected to be an exceptional case.

Table 40. Contact parameters

	Parameters		Kitchen floor	Reference
Contact Definition	Frequency	(/week)	1	Estimate
	Use duration	(min)	15	Weegels (1997)
	Total duration	(min)	15	Weegels (1997)

5.5.2.2 Dermal exposure

Dermal contact occurs during cleaning the kitchen floor with a cloth, when rinsing the cloth in a bucket of water, and when using the cloth to wipe the floor. The concentration to which one is exposed in both phases is the same.
The scenario used for the assessment of dermal exposure when cleaning the kitchen floor is the fixed volume scenario. The density of all purpose cleaner is 1.04 g/l (Colgate Palmolive, 1995). The weight fraction of the hypochlorite ion in diluted all purpose cleaner is determined by multiplying the average concentration (N=20) of all purpose cleaner in water as determined by Weegels (1997) and the weight fraction from the safety data sheet (5%). The average concentration is 9.1 g/l. The weight fraction in undiluted product is 5%. This results in a weight fraction in diluted product of 455 mg/kg (9.1*1000*0.05 mg/l). On the package of Ajax Gel 2 in 1 it is recommended to add 35 ml (one cap) in 2l water. This results in a weight fraction 2 times higher than observed, 910 mg/kg hypochlorite ion in the soapsuds (35*1.04*1000*0.05/2 mg/l). Since the data provided by Weegels (1997) are based on observations, these data are used for the assessment. The dilution factor is expressed in the concentration and can therefore be set to 1.

Table 41. Dermal exposure parameters

	Parameters		Cleaning the kitchen floor	Reference
Fixed volume	Density	(kg/l)	1.04	Colgate Palmolive (1995)
	Weight fraction	(mg/kg)	455	Weegels (1997)
	Dilution factor	-	1	Undiluted use

Results dermal exposure

The mean event dermal exposure concentration to hypochlorite ion when cleaning the kitchen floor, calculated with the CONSEXPO fixed volume scenario equals $4.732*10^{-1}$ mg/cm^3.

Table 42. Dermal exposure to hypochlorite ion calculated with CONSEXPO

		Exposure
Mean event concentration	(mg/cm^3)	$4.732*10^{-1}$
Year average concentration	(mg/cm^3)	$7.126*10^{-4}$

5.5.2.3 Inhalation Exposure

Inhalation exposure to hypochlorous acid is best described with the evaporation from mixture model. The release area of the floor is 4.16 m^2 (see appendix 3, release area kitchen floor (standard kitchen)). The room volume and effective ventilation rates are the defaults provided by Bremmer & Van Veen (1999). The weight fraction is based on the concentration of the soapsuds used for cleaning (Weegels, 1997) and on the assumption that 5% of the concentration sodiumhypochlorite in all-purpose cleaner (5%) is present as hypochlorous acid resulting in a weight fraction of 22.25 mg/kg (concentration all purpose cleaner in water is 9.1 g/l). The molecular weight of the matrix is the molecular weight of water.

Table 43. Inhalation exposure to hypochlorous acid

	Parameter			Reference
Evaporation from Mixture	Release area	(m^2)	4.16	Appendix 3
	Temperature	(K)	293	Van Veen, 1997
	Room volume	(m^3)	15	Bremmer & Van Veen (1997)
	Effective ventilation rate	(m^3/hr)	37.5	Bremmer & Van Veen (1999)
	Weight fraction	(mg/kg)	22.25	Weegels (1997)
	Molecular weight of the solvent	(g/mol)	18	Molar weight water

Results inhalation exposure

The mean event inhalation exposure concentration to hypochlorous acid when cleaning the kitchen floor is $3.15*10^{-14}$ mg/m^3. See also Table 44.

Table 44. Inhalation exposure to hypochlorous acid calculated with CONSEXPO

		Exposure
Mean event concentration	(mg/m^3)	$3.150*10^{-14}$
Year average exposure	(mg/m^3)	$4.743*10^{-17}$

5.5.2.4 Oral exposure

Oral exposure is expected to occur via hand-to-mouth contact only. It is assumed that during the cleaning event of 15 minutes, the amount of hypochlorite ion attached to 1 cm^2 is taken in 5 times.

Oral exposure via hand-to-mouth contact while cleaning the floor with diluted all-purpose cleaner is comparable to oral exposure to glutaraldehyde in dishwashing liquid via this route. The main difference is that the weight fraction of hypochlorite ion in all purpose-cleaner is a factor 450 higher than glutaraldehyde in dishwater ($4.6*10^{-4}$ vs. $1.02*10^{-6}$ (w/w)). The amount of water attaching to a hand is 6.7 mg/cm^2 (female hand) and 8.5 mg/cm^2 (male hand) (see Appendix 4).

OUTDATED

This results in $3.1*10^{-3}$ mg hypochlorite ion on a square centimeter of the female hand and $3.9*10^{-3}$ of the male hand.
If these amounts are taken in 5 times during cleaning the kitchen floor, this results in oral exposure to hypochlorite ion of 0.0155 mg for women and 0.0195 mg for men.

5.6 Summary of results

In this paragraph the results of the exposure estimates described in this chapter are summarised. A description of the models used for the exposure assessments and the source and status of the parameters can be found in the previous paragraphs.

In Table 45 exposure to glutaraldehyde when doing the dishes with a soapsuds of dishwashing liquid and water and when cleaning hands with undiluted dishwashing liquid is summarised.

Table 45. Exposure to glutaraldehyde in dishwashing liquid when doing the dishes and cleaning hands

			Doing the dishes	Cleaning hands
Dermal exposure	Mean event concentration	(mg/cm^3)	$1.02*10^{-3}$	1.02
	Year average concentration	(mg/cm^3)	$1.08*10^{-5}$	$7.17*10^{-2}$
Inhalation exposure	Mean event concentration	(mg/m^3)	$7.90*10^{-7}$	$3.87*10^{-5}$
	Year average concentration	(mg/m^3)	$1.67*10^{-8}$	$2.72*10^{-8}$
Oral exposure	Mean event concentration	(mg/day)	0.8	-

In Table 46 exposure to isopropylalcohol when cleaning the kitchen working top with hygienic cleaning napkins can be found.

Table 46. Exposure to isopropylalcohol when cleaning the kitchen working top

			Cleaning the kitchen working top
Dermal exposure	Mean event concentration	(mg/cm^3)	50
	Year average concentration	(mg/cm^3)	10.54
Inhalation exposure	Mean event concentration	(mg/m^3)	$2.33*10^{1}$
	Year average concentration	(mg/m^3)	$1.64*10^{-1}$
Oral exposure	Mean event concentration	(mg/day)	0.03

In Table 47, exposure to DDAC resulting from the use of hygienic cleaning spray cleaner when cleaning the kitchen working top is summarised.

Table 47. Exposure to DDAC when cleaning the kitchen working top

			Cleaning the kitchen working top
Dermal exposure	Mean event concentration	(mg/cm^3)	2
	Year average concentration	(mg/cm^3)	$1.90*10^{-3}$
Inhalation exposure	Mean event concentration	(mg/m^3)	$3.18*10^{-4}$
	Year average concentration	(mg/m^3)	$1.51*10^{-6}$
Oral exposure	Mean event concentration	(mg/day)	0.032 (♂) / 0.026 (♀)

In Table 48, the results of the exposure assessments for bleach containing products are described. Dermal and oral exposure have been assessed to OCl^-, inhalation exposure to HOCl.

Table 48. Exposure to hypochlorite ion and hypochlorous acid when cleaning the sink, the kitchen working top and the floor.

			Cleaning sink	Cleaning kitchen working top	Cleaning kitchen floor with dilute all purpose cleaner
Dermal exposure to OCl^-	Mean event concentration	(mg/cm^3)	(1) 55 (2) 75 (3) 52	(1) 55 (2) 75 (3) 52	$4.73*10^{-1}$
	Year average concentration	(mg/cm^3)	(1) $2.76*10^{-2}$ (2) $3.77*10^{-2}$ (3) $2.61*10^{-2}$	(1) $5.52*10^{-2}$ (2) $7.53*10^{-2}$ (3) $5.22*10^{-2}$	$7.13*10^{-4}$
Inhalation exposure to HOCl	Mean event concentration	(mg/m^3)	$2.79*10^{-13}$	$4.55*10^{-12}$	$3.15*10^{-14}$
	Year average concentration	(mg/m^3)	$1.40*10^{-16}$	$4.57*10^{-15}$	$4.73*10^{-17}$
Oral exposure to OCl^-	Mean event concentration	(mg/day)			0.019 (♂) /0.016 (♀)

(1) Dermal exposure to OCl^- in bleach
(2) Dermal exposure to OCl^- in abrasive
(3) Dermal exposure to OCl^- all purpose cleaner

6 Risk assessment

In this chapter, a comparison is made between exposure to the assessed compounds as a result from the use of cleaning products in the kitchen, and adverse health effects associated with these compounds, based on a first toxicological screening. This comparison yields the risk on adverse health effects due to hygienic cleaning products used in the kitchen. The toxicology of the selected compounds is discussed per route of exposure.

6.1 Glutaraldehyde in dishwashing liquid

In this paragraph the results of the exposure assessment are combined with literature on the toxicity of glutaraldehyde to identify risks.

6.1.1 Toxicology of glutaraldehyde

Dermal exposure
Skin irritation
Several animal skin irritation tests indicate that glutaraldehyde solutions are irritating to the skin. Aqueous solutions of 45% and 50% are corrosive to the skin of rabbits. Irritation effects were still observed with a 2% solution aqueous solution. No effects were observed with 1% solution (NOHSC, 1994). In a study by Myers *et al.* (1994) the irritancy of 2% buffered solution was found to be similar to the effect of the unbuffered solution. No effects were observed with a 1% solution (HSE, 1997).
In humans, a 2% glutaraldehyde solution used in health care industry for disinfection purposes, was also found to be slightly irritant to the skin (Gorman & Scott, 1980). Glutaraldehyde is irritant to human skin in concentrations of 2-10%. A solution of 0.5% was found not to be irritant (HSE, 1997).

Skin sensitisation
A guinea pig sensitisation maximisation test showed that both a 2% aqueous solution and a 2% alkalinised solution of glutaraldehyde are skin sensitisers. Based on the incidence and the severity of reactions, it is concluded that the aqueous solution was a stronger sensitiser than the alkalinised solution (NOHSC, 1994). Again, these results from animal assays are also observed in humans. In literature several cases are described of people developing allergic skin reactions after contacting glutaraldehyde solutions. Exposure to a 2% solution resulted in a development of allergic contact dermatitis; patch testing with 0.5% and 1% gave positive results (NOHSC, 1994). In experimental studies with human volunteers, 7 out of 30 induced with 5% glutaraldehyde became sensitised. Induction treatment of 10 applications over 3.5 weeks using 0.5 g of 0.1% solution, followed after two weeks without treatment by a challenge patch with 0.5% glutaraldehyde, did not cause

sensitisation (HSE, 1997). In Australia glutaraldehyde is classified as a dermal sensitiser in concentrations $\geq$ 1% (NOHSC, 1994). In conclusion, there is sufficient evidence that glutaraldehyde is a skin sentisiser in humans.

Repeated dermal exposure
Glutaraldehyde showed no significant treatment related systemic toxicity in rats at the highest dose tested (75 mg/kg/day), it is therefore concluded that the NOAEL for systemic effects is >75 mg/kg/day. However, gross and microscopic changes in the skin were observed at the lowest dose (25 mg/kg/day), so a NOAEL for local toxicity could not be identified (HSE, 1997).

Inhalation Exposure
Respiratory irritation
From acute inhalation studies it can be concluded that glutaraldehyde is a respiratory irritant in test animals at concentrations from 8.18 mg/m^3. Another study showed that the breathing rate of mice was significantly reduced at all tested vapour concentrations (6.71-150.1 mg/m^3), no level of tolerance being achieved (NOHSC, 1994).
Respiratory irritation was also reported in human case reports in the literature. Irritation of nose and throat was experienced in hospital workers in Sweden exposed to concentrations lower than 0.818 mg/m^3 (NOHSC, 1994).

Respiratory sensitisation
A number of case reports are published in literature which have indicated that glutaraldehyde may be a respiratory sensitiser. In the absence of adequate case reporting or an identified immune mechanism, NOHSC (1994) concludes that it is difficult to say definitively that glutaraldehyde is a respiratory sensitiser (NOHSC, 1994). The English HSE concludes, however, that there exists a fair body of evidence, including groups of cases supported by positive bronchial challenge tests and data from surveys, that indicates that glutaraldehyde has the potential to cause occupational asthma. No no-effect level could be determined from the data available. In English legislation, a new 8-hour TWA (Time Weighted Average)has come into force in April 1999 of 0.02 ppm (0.082 mg/m^3) and a 15-minute STEL (Short Term Exposure Limit) of 0.05 ppm (0.2045 mg/m^3) that must never be exceeded (BOHS, 1999).

Repeated inhalation exposure
The predominant effect of repeated inhalation exposure to glutaraldehyde is irritation of the upper respiratory tract. In a 13-week study a NOAEL of 0.511 mg/m^3 was apparent for rats, in female mice however, some evidence of an inflammatory response was obtained at 0.256 mg/m^3. At concentrations up to and including 2.05 mg/m^3, effects in rats and male mice were generally minimal in severity and/or occurred only in a small proportion of animals (HSE, 1997).

In epidemiological studies with exposed and non-exposed hospital staff/nurses, no association was found between inhalation exposure and reprotoxicity (Beauchamp *et al.*, 1992; HSE, 1997). Therefore, HSE concludes that it does not appear that glutaraldehyde causes reproductive toxicity in humans (HSE, 1997). An epidemiological study in which the mortality and cancer incidence in 186 men involved in glutaraldehyde production was examined, did not provide any evidence that gluataraldehyde caused cancer or increased mortality in the workforce (HSE, 1997).

Oral exposure

Repeated oral exposure

Little information is available on toxicity following oral administration of glutaraldehyde. In studies in rats involving estimated doses of glutaraldehyde of 100-120 mg/kg/day in drinking water for 13 weeks, no findings of toxicological significance were found (HSE, 1997).

A recent oral study provided no convincing evidence for any carcinogenic action in rats following administration of glutaraldehyde in drinking water for up to two years, at levels that caused irritation in the stomach (HSE, 1997).

Genotoxicity tests

In vitro, glutaraldehyde is a direct acting mutagen in bacterial and mammalian cells. In vivo, the results of four tests using several distant target tissues were negative. There are difficulties in interpreting the results obtained in standard tests which require transport of reactive substances to a distant target site. Given the ability of glutaraldehyde to react directly with macromolecules, the potential to act at the site of contact is of concern. However, HSE concludes that the clearly negative results of recent, good-quality bone marrow cytogenetics and peripheral blood micronucleus tests, together with those of the liver UDS (unscheduled DNA synthesis) assay, provide reassurrance that the genotoxic effects shown by glutaraldehyde in vitro are unlikely to be expressed in vivo.

No human data are available concerning genotoxicity (HSE, 1997).

6.1.2 Risk assessment

From the toxicological description it is concluded that the adverse effects caused by glutaraldehyde are irritant and sensitising in nature. These effects are caused by direct contact of glutaraldehyde solutions with tissue. It is therefore possible to compare mean event exposure concentrations with the effect levels.

Dermal Exposure

Dermal exposure during dishwashing and during the cleaning of hands with dishwashing liquid is compared with the levels at which no adverse effects are found in Table 49. This level is for skin irritation is 5 mg/cm^3 (or 0.5%) and for dermal sensitisation 1 mg/cm^3 (0.1%).

According to the exposure assessment described in the previous chapter, dermal exposure during washing up is $1.02*10^{-3}$ mg/cm^3. Since exposure is a factor of $5*10^3$ lower than the level without effects, no adverse effects are expected.

When cleaning hands with undiluted dishwashing liquid, exposure does not exceed the level at which no irritation effects are found (0.5%). But exposure is at the same level as the highest reported level at which no sensitisation effects are found in humans. Based on these data, a sensitisation reaction could be possible. However, in Australia, glutaraldehyde is classified as sensitising in concentrations ≥1%, a level based on animal testing and human evidence in literature (NOHSC, 1994). Taking this into consideration together with the fact that the concentration in dishwashing liquid (concentration of up to 0.1%) is based on a guideline for cosmetics since no such directions are set for detergents (P&G, 1999) it is not expected that a sensitisation reaction is induced at this level of exposure.

The NOAEL for systemic effects after repeated dermal exposure is >75 mg/kg/day. This exposure level will not be reached as a result of using dishwashing liquid for the here described tasks.

Table 49. Dermal exposure compared with dermal effects

			Level without dermal irritation	Level without dermal sensitisation	NOAEL systemic effects Repeated dermal exposure
			5 mg/cm^3	1 mg/cm^3	75 mg/kg/day
Dermal Exposure	Dishwashing	$1.02*10^{-3}$ mg/cm^3	- -	- -	- -
	Cleaning hands	1.02 mg/cm^3	- -	-	- -

- - no adverse effects expected, - occurrence of adverse effects?

Inhalation exposure

In Table 50 inhalation exposure and the 8-hour TWA are compared. The fact that the 8-hour TWA is by far not exceeded also indicates that no irritation or sensitisation effects will occur due to the use of dishwashing liquid.

Table 50. Inhalation exposure compared with the 8-hour TWA

			8-hour TWA
			0.082 mg/m^3
Inhalation exposure	Dishwashing	$7.9*10^{-7}$ mg/m^3	- -
	Cleaning hands	$3.87*10^{-5}$ mg/m^3	- -

-- no adverse effects expected

Oral exposure

In animal tests a dose of 120 mg/kg/day did not cause any significant health effects. Oral exposure to dishwashing liquid can be caused by hand-to-mouth contact and by oral intake of residuals on washed dishes and glassware. Oral exposure via these two routes is estimated in paragraph 5.1.4 as 0.8 mg/day. It is therefore not expected that any adverse effects will be caused by oral exposure.

6.1.3 Conclusion

It is concluded that exposure to glutaraldehyde via the use of dishwashing liquid will probably not lead to adverse health effects. However, when contacting undiluted dishwashing liquid, dermal exposure is slightly higher than the level at which no sensitisation effects in humans are observed. Based on these data it is difficult to definitively exclude the occurrence of sensitisation effects. When considering that exposure levels of 0.1% are accepted in cosmetics and that concentrations $\geq$ 1% are classified as sensitising, it is not expected that exposure to glutaraldehyde via the use of dishwashing liquid will cause sensitisation effects.

6.2 Isopropylalcohol in napkins

In this paragraph, the toxicology of this compound will be discussed for the dermal, inhalation and oral route of exposure. Hereafter, the results of the exposure assessments are compared with this toxicological information to assess the risk on adverse health effects following exposure due to the use of this hygienic cleaning product.

6.2.1 Toxicology of isopropylalcohol

Dermal exposure

Irritation

No irritation was found after application of undiluted isopropylalcohol to the clipped or abraded skin of rabbits and guinea pigs (Gezondheidsraad, 1994). When testing irritation effects of undiluted product in men, Haddock and Wilkin (1982) found no reaction on the nonhydrated forearm. After immersion of the forearm skin in tepid water for ten minutes, however they did find notable erythema in eight out of ten subjects, probably due to increased cutaneous permeability following hydration (Gezondheidsraad, 1994, WHO, 1990a). No irritation was found after application of 0.5 ml undiluted isopropylalcohol on the skin of the back (Gezondheidsraad, 1994).

Sensitisation

No animal experiments are available concerning skin sensitisation. In man, several cases of contact dermatitis from using commercially available cleaning swabs containing isopropylalcohol have been reported. In one of eight subjects showing contact dermatitis after contact with these swabs, patch testing confirmed that isopropylalcohol was the causative agent. In the other subjects, patch testing revealed that another agent caused the effect (Gezondheidsraad, 1994; WHO, 1990a). The mechanism of alcohol hypersensitivity however is not clear (WHO, 1990a).

Inhalation exposure

Irritation

In rats that were exposed to 500 mg/m^3 isopropylalcohol, irritant effects on the respiratory system were found such as thinning of the alveolar walls, perivascular infiltration, pneunomia and bronchitis (WHO, 1990a). With respect to irritative effects in rats after repeated exposure (6 hours a day, 5 days a week for 14 weeks, a NOAEL of 250 mg/m^3 can be derived (Gezondheidsraad, 1994).

In another study, ten healthy men were exposed to isopropylalcohol vapour at concentrations of 490, 980 or 1970 mg/m^3 for 3 to 5 minutes. The volunteers judged irritation to be ‘mild’ at 980 mg/m^3 and not severe at 1970 mg/m^3. The subjects themselves judged exposure to 490 mg/m^3 to be satisfactory for their own 8-hour occupational exposures. The validity of this study is doubtful however, because of the subjective criteria used, the lack of control exposures and the unreliability of exposure levels (WHO, 1990a).

Acute single exposure

The toxicity following acute or single exposure is low. No effects were seen in rats exposed for six hours to concentrations up to 1925 mg/m^3. At the next higher dose tested in another experiment, 3750 mg/m^3, small transient behavioural effects were observed in male rats only. Exposure to higher levels resulted in more, more severe and longer lasting nervous-system related effects. Exposure of 37500 mg/m^3 was lethal. At concentrations of 10000 mg/m^3 and higher histopathological changes were noted in liver, lungs and spleen (Gezondheidsraad, 1994).

Repeated inhalation exposure

For isopropylalchol a NOAEL can be derived from inhalation studies in which rats and mice were exposed 6 hours, 5 days per week for 14 weeks. The NOAEL for systemic effects in both rats and mice is 3750 mg/m^3 (Gezondheidsraad, 1994).

Inhalation exposure of pregnant rats to isopropylalcohol provided a LOAEL of 18327 mg/m^3 and a NOAEL of 9001 mg/m^3 for maternal toxicity. In the same study, 9001 mg/m^3 was a LOAEL for developmental toxicity with no demonstration of a NOAEL (WHO, 1990a).

Occupational exposure limit

The Dutch Expert Committee on Occupational Standards recommends a health-based occupational exposure limit of 650 mg/m^3 as an 8-hour time weighted average concentration based on the above described study that in rats a concentration of 1925 mg/m^3 no adverse effects are observed (Gezondheidsraad, 1994).

Oral exposure

No appropriate animal data are available for a determination of a dose response relationship on oral intake and effects, and for the determination of a NOAEL (Gezondheidsraad, 1994). In a study in which 8 healthy men drank a daily dose of 2.6 or 6.4 mg isopropylalcohol per kg body weight in diluted syrup for 6 weeks, no adverse effects were observed. Investigations included heamatology, blood chemistry, urinalysis and ophthalmoscopy (WHO, 1990a).

Genotoxiciy and carcinogenicity

Based on (a) the mainly negative results in vivo gene mutation tests in bacteria and in mammalian cells, and (b) on the lack of induction of sister chromatid exchanges in vitro and (c) of micronuclei in mouse bone marrow in vivo (the latter outweighing the positive results of a doubtful rat bone marrow assay), the committee concludes that isopropylalchohol is not mutagenic or genotoxic (Gezondheidsraad, 1994).
The data available are inadequate to assess the carcinogenicity of isopropylalcohol in animals. There are no data to assess the carcinogenicity of isopropylalchol itself in humans (WHO, 1990a).

6.2.2 Risk assessment

Dermal Exposure

Dermal exposure due to the use of hygienic cleaning napkins for cleaning the kitchen working top is 50 mg/cm^3. No dermal sensitisation is observed in either human or animal studies. In hydrated skin however, dermal irritation of the forearm was observed as a result of exposure to *undiluted* isopropylalcohol.
It is imaginable that the product is used after the skin is immersed in water, for example after dishwashing. However, it is not expected exposure to a 5% solution of isopropylalcohol will cause these same irritating effects as the undiluted solution. Therefore it is concluded that no adverse effects will occur resulting from dermal exposure to isopropylalcohol.

Inhalation exposure

Inhalation exposure resulting from the use of hygienic cleaning napkins is 7.86 mg/m^3 averaged over the room volume of 15m^3 (non-user scenario), and 23.3 mg/m^3 (user scenario) averaged over a personal volume of 5m^3. This exposure concentration is far below the health based occupational exposure limit of 650 mg/m^3 (8-hour TWA). Considering this standard, it is not be expected that adverse health effects occur following the use of hygienic cleaning napkins.

Oral exposure

In a human assay in which toxicity was studied after daily ingestion of 2.6 to 6.4 mg/kg bw, no adverse effects are found. Oral exposure to isopropylalcohol is limited to ingestion via hand-to-mouth contact. Oral exposure is assessed in paragraph 5.2.4 as 0.03 mg/day. When comparing these data, no adverse effects due to oral exposure are expected.

6.2.3 Conclusion

In conclusion it is not expected that adverse effects will occur due to the use of hygienic cleaning napkins in the kitchen.

6.3 DDAC in spray cleaners

The toxicology of DDAC is compared with exposure to DDAC via the use of hygienic cleaning spray cleaners. Only limited information on the toxicology of DDAC is available in literature. The available toxicity data are summarised.

6.3.1 Toxicology of DDAC

Dermal exposure

Dermal irritation

Severe irritation was observed in animals after a 24-hour dermal exposure to concentrations of 56% DDAC (Van Hoeven &Van Leeuwen, 1994). Severe irritation was also observed in rabbits after application of 55.7% aqueous solution of DDAC under cover to the intact and abraded skin of rabbits for 72 hours (BIBRA, 1990). Moderate irritation was found after exposure to 5 and 0.5% DDAC. No irritation occurred with 0.1%, 0.05% and 0.005%. Application of 0.1% (0.5ml) caused slight irritation when applied 2-5 daily for 6 hours. A piece of woollen fabric impregnated with 0.25% DDAC did not cause skin irritation in humans during 48-hour exposure (Van Hoeven & Van Leeuwen, 1994).

In a 13-week dermal study, no signs of systemic toxicity were observed up to a dose level of 12 mg/kg b.w. (equivalent to a concentration of 0.6%). Skin irritation was observed in most animals of the high dose group (0.6% concentration) and in some animals of the mid dose group. The lowest dose in this study (0.1% w/w) is considered as level without irritation effects to the skin. A study with human volunteers, did not show skin irritation in 49 out of 50 subjects after exposure to 0.05% up to 0.5% DDAC, and in the remaining subject slight irritation at concentrations of 0.25% and 0.5% (Van Hoeven & Van Leeuwen, 1994).

Dermal sensitisation

An epicutaneous maximisation test with DDAC had negative results. This indicates that DDAC has no sensitising properties (Van Hoeven & Van Leeuwen, 1994). Further more, there are no relevant data identified on sensitisation or intolerance (BIBRA, 1990).

Reproductive toxicity

No relevant data on DDAC are identified. Single doses of 50 or 200 mg/kg bw of the structurally related compound di*cetyl*dimethylammonium chloride administered by subcutaneous injection to pregnant mice demonstrated a weak ability to induce foetal malformations. Another structurally related compound di*stearyl*(C18)dimethylammonium chloride applied to the skin of rats on days 6-15 of pregnancy at doses of around 120 mg/kg bw/day did not induce foetal malformations or foetal deaths (BIBRA, 1990).

Inhalation exposure

No information is available in literature on the toxicity after inhalation exposure of DDAC.

Oral exposure

Quaternary ammonium compounds (quats) have serious irritating properties. The most important target organ for orally taken up quats, is the gastro-intestinal tract. Effects range from decreased food consumption and growth, loss of moist, to serious damage to the gastro-intestinal tract (De Jong, 1996).

In an oral study carried out with dietary levels of up to 3000 mg a.i./kg feed, no abnormalities were observed at 1000 mg/kg feed. A DWE in mg / kg b.w. cannot be established because the dose that did not cause effects in the rats that received 1000 mg/kg feed was about the same as the dose that killed the rats that received 3000 mg/kg feed (because of the severely decreased food consumption in the latter group). Therefore and because of the observed effects, the toxic action of the test substance during repeated dosing is considered to be mainly local (mucosal irritation and bacteriotoxicity in the gastro-intestinal tract) and concentration controlled rather than systemic and dose (per kg b.w.) controlled.
Another oral 90-day study in rats was carried out with dietary levels of 10 up to 1000 mg a.i./kg feed. At 1000 mg/kg feed decreased water consumption and severely increased caecum weight was observed; with 400 mg/kg feed no effects were observed.
In 1994, the National Institute for Public Health and the Environment (RIVM) has determined ADI's (Acceptable Daily Intake) for the category of quaternary ammonium compounds without benzyl group among others consisting of DDAC. The ADI for this category is 0.04 mg/kg bw/day or 0.8 mg/kg feed. These values are based on NOAELs that resulted from semi-chronic research by rats. These NOAEL's are divided by a factor 20. The safety factor that was used for the derivation of the ADI was 500. This factor should correct for uncertainty from semi-chronic to

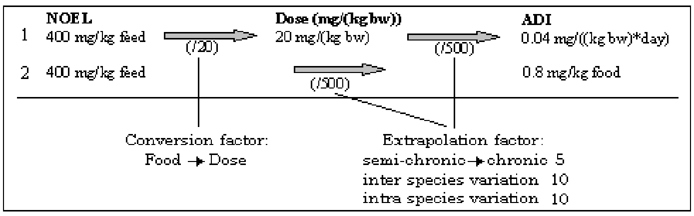


Figure 12. Derivation of the ADI from the NOEL for DDAC

chronic research) Since the effects caused by quats seem to be concentration related rather than dose related, the ADI was also expressed in amount per weight feed (see Figure 12) (De Jong, 1996).

Mutagenicity (in vitro)

The following mutagenicity studies have been carried out; Ames/Salmonella test (5 strains), and tests on chromosome aberrations and forward mutations (hypoxantine guanine phosphoribolyl transferase (HGPRT)) in Chinese hamster ovary cells in vitro. These tests have shown negative results, both in the absence and presence of metabolic activation. An in vivo test on chromosome aberrations in rats was also negative (Van Hoeven & Van Leeuwen, 1994).

6.3.2 Risk Assessment

Dermal Exposure
Dermal exposure to undiluted product corresponds with exposure to 2 mg/cm^3, or 0.2%. In a study with human volunteers, 1 subject out of 50 experienced slight erythema at a concentration of 0.25% and 0.5%. In an animal assay, application of 0.1% (0.5 ml for 6 hours) caused slight irritation when applied 2-5 daily. These data suggest that contact with undiluted product containing 0.2% DDAC might lead to slight erythema in sensitive humans.

Inhalation Exposure
Inhalation exposure to DDAC during the use of a hygienic cleaning trigger spray is 3.18*10^{-4} mg/m^3. Due to the absence of inhalation toxicity in literature, no conclusion can be drawn on inhalation toxicity.

Oral toxicity
Oral exposure to DDAC will only occur due to hand-to-mouth contact. Since dermal contact to the compound is limited due to the use of a cloth when cleaning a surface, oral exposure via hand-to-mouth contact will occur only minimally. Oral exposure for men is estimated in paragraph 5.3.4as 0.032 mg/day and as 0.026 mg/day for women.
The ADI for oral toxicity as established by the RIVM is 0.04 mg/kg bw/ day, which implies an acceptable daily intake for an adult of 70 kg of 2.8 mg/day. When comparing exposure and the ADI, no adverse effects are expected.

6.3.3 Conclusion

In conclusion it is expected that the only adverse health effect that might occur due to the use of DDAC containing hygienic cleaning trigger spray, is slight dermal irritation. Due to the lack of toxicity data following inhalation exposure, it is impossible to predict the occurrence of adverse health effects. When considering the dermal and oral irritating properties of the compound, it might be possible that the compound causes irritation effects on the respiratory tract as well.

6.4 Sodiumhypochlorite in bleach containing products

6.4.1 Toxicology of sodiumhypochlorite bleaches

Exposure was assessed to the hypochlorite ion (OCl^-) and hypochlorous acid present in sodiumhypochlorite bleaches. Since no information was available on the hypochlorite ion, and hypochlorous acid, the toxicology of bleach (sodiumhypochlorite solutions) is described. Bleach containing products all have an alkaline pH (10.5-13), at which the equilibrium shifts towards OCl^- (see equation 2). It is therefore possible to compare the toxicity caused by sodiumhypochlorite bleaches with exposure to OCl^-. OCl^- is hardly volatile, which indicates that although the equilibrium has shifted almost entirely to OCl^-, inhalation exposure will occur to HOCl which is 10^5 times more volatile than OCl^-.

$$NaOCl + H_2O \rightleftarrows HOCl + NaOH \qquad (1)$$

$$HOCl \rightleftarrows H^+ + OCl^- \qquad (2)$$

Dermal exposure

Skin irritation

The potential of NaOCl solutions to irritate the skin may be due to the presence of the reactive species hypochlorite ions (OCl^-), hypochlorous acid (HOCl) or sodium hydroxide (NaOH). A study performed by Hostynek *et al.* (1990) showed increased skin irritation when the equilibrium of a hypochlorite solution was shifted towards HOCl by decreasing the alkalinity of the solution. Furthermore, it was shown that the irritation effect of NaOCl solutions depends on the cumulative effect resulting from equilibrium between OCl^-, HOCl and NaOH (Racioppi *et al*, 1994).

Skin irritation tests in rabbits and guinea pigs indicated that undiluted solutions (5.5%NaOCl) have a moderate skin irritation potential and that diluted solutions (0.6% NaOCl) are slightly or not irritating. In human skin tests with 5.25% NaOCl (pH 10.7) and 4-6% NaOCl under occluded patches resulted in severe respectively moderate effects. Uncovered exposure to 0.25-4% NaOCl produced no skin reaction (Racioppi *et al*, 1994).

Nixon *et al.*, (1975) reported that undiluted bleach containing 5.25% NaOCl (pH10.7) was severely irritating to human intact skin after 4 hour exposure under occluded patch conditions. A disinfectant containing 4-6% NaOCl produced moderately irritating effects under occluded patch. Uncovered applications of 0.25-4% NaOCl produced no skin reaction. In 15 of 69 dermatitis patients patch tested with 2% NaOCl (48 hr covered contact) weak to moderate irritation was found (Racioppi *et al*, 1994).

Skin sensitisation

Sodium hypochlorite solutions do not induce contact sensitisation (Racioppi *et al.*, 1994; AISE, 1997). However, there have been rare reports of alleged allergic contact sensitisation. These cases do not provide evidence of sensitisation since they were either:

- in multi-sensitised individuals,
- or due to non-immunologic contact urticaria,
- or no direct link could be established.

Given the widespread use of sodiumhypochlorite, it can be concluded that the likelihood of allergic contact dermatitis is negligible. This is supported by unpublished Procter and Gamble data from predictive sensitisation tests conducted in human volunteers as well as in guinea pigs, where no sensitisation was found (Racioppi *et al.*,1994).

Inhalation exposure

Inhalation exposure to sodiumhypochlorite bleach is not reported because no harmful gases are released by bleach solutions in appreciable amounts under normal use conditions. Inhalation

toxicity is generally the result of erroneous mixing of bleach with ammonia or acids.
When bleach is mixed with ammonia, chloramine compounds (mainly mono chloramine (NH_2Cl) are formed. Adverse effects in the lungs are caused by the formation of HOCl and active oxygen when chloramine compounds contact the moist mucous membranes of the lung. Cases of serous toxic pneumonitis have been reported.
Mixing bleach with acids can cause the release of Cl_2 gas when the pH drops below 2. In most described cases the amounts of chlorine are too minute to be of any health concern. However, in rare cases, chlorine release caused repiratory irritation ranging in severity from slight discomfort to tracheobronchitis or acute respiratory distress depending on amounts inhaled, duration of exposure and closed room settings. Symptoms are coughing, irritaton of eyes, nose and throat and nausea (Racioppi *et al*., 1994).

Oral exposure

Acute oral exposure

After ingestion of sodium hypochlorite, this compound interacts with the acidic environment of the stomach, producing hypochlorous acid. This can lead to irritation of the mucous membranes and skin, but does not cause stricture formation (Klaassen, 1996). Non-human acute toxicity studies showed that commercial hypochlorite bleaches have a low order of toxicity (LD_{50} values were greater than 2000 mg/kg bw).
In (adult) humans the lethal dose of NaOCl was reported to be about 200 ml 3-6% containing NaOCl solution. However, there are reports of patients surviving swallowing NaOCl solutions up to 1 litre (5.25% solution) and about 500 ml of a 10% NaOCl solution (Racioppi et al., 1994).
Overall, the acute oral toxicity of hypochlorite bleaches in humans is described as ‘slightly toxic’ and ‘not very toxic’(Racioppi *et al*, 1994; Klaassen, 1996).

Aspiration of bleach in the lungs following ingestion has been reported as the cause of two fatalities, after accidental exposure to large volumes of hypochlortie bleach solutions. In dogs, ingestion of 5 ml 5.25% NaOCl bleach caused a prompt emetic effect. This fairly strong emetic response thought to reduce the risk of adverse effects deriving from the systemic absorption of ingredients (Racioppi *et al.*, 1994).
The clinical consequences of ingestion are acidosis due to excess of sodium and chlorine concentration in the blood after ingestion of 500 ml 10% NaOCl, with recovery in 5 days. Severe irritation of the oesophageal mucosa was observed in one case of 26 children that had ingested bleach. In some of the other 25 patients minor transient irritation effects were observed. In conclusion, effects of accidental ingestion of domestic sodium hypochlorite bleaches are not expected to lead to severe or permanent damage of the gastro-intestinal tract, while recovery is rapid and without any permanent health consequences (Racioppi *et al*,1994).

Chronic oral exposure

Carcinogenicity

Sodium hypochlorite was tested for carcinogenicity in a two-year study in male and female mice and rats by oral administration of drinking water, and in limited studies in female mice by skin

application. Sodium hypochlorite was also tested for promoting effects in female Sencar mice following initiation with 7,12-dimethylbez(a)antracene and in female mice following initiation with nitroquinoline 1-oxide.
Sodiumhypochlortie administered in drinkingwater did not increase the proportion of tumours in rats and mice. Sodiumhypochlorite applied to the skin did not produce skin tumours and no skin promoting effect was observed in the study with 7,12-dimethylbenz(a)antrracene, whereas some effect was seen in the study with 4-nitroquinoline-1-oxide.
Drinking-water containing 100 mg/l chlorine was tested for carcinogenicity in a multigeneration study in male and female BDII rats. No increase in the incidence of tumours was seen in treated animals relative to controls through six generations (WHO, 1990b).

There are no human carcinogenicity data available. Sodiumhypochlorite induced genotoxic effects in bacteria. In single studies, chromosomal aberrations were observed in cultured mammalian cells, whereas sister chromatid exchange but no chromosomal aberration was seen in cultured human cells. In a single study, micronuclei were induced in newt larvae. In mice, no induction of micronuclei, aneuploidy or chromosomal aberrations was observed in bone marrow, but abnormal sperm morphology was seen after administration of sodium hypochlorite (WHO, 1990b).

Based on the above described data, the IARC concluded that there is inadequate evidence for the carcinogenicity of hypochlorite salts in experimental animals. No data were available from studies in humans on the carcinogenicity of hypochlorite salts. Therefore, hypochlorite salts are not classifiable as to their carcinogenicity to humans (WHO, 1990b).

6.4.2 Risk assessment

Dermal exposure

When bleach is used undiluted, dermal exposure to bleach containing products ranges from 52 mg/cm^3 (bleach) to 75 (abrasive) mg/cm^3, depending on the density of the product. Exposure to hypochlorite ion during diluted use equals 0.47 mg/cm^3. In human skin tests, the only irritation effects reported are due to exposure under occluded patch conditions. When using a bleach solution, contact will be uncovered. Since uncovered applications of sodiumhypochlorite solutions did not induce skin irritation, it is not expected that the use of diluted or undiluted bleach will cause an irritant reaction. In literature there is no substantial evidence that sodiumhypochlorite solutions can cause a sensitising reaction, therefore, no sensitisation is expected.

Inhalation exposure

Inhalation exposure to sodiumhypochlorite solutions is not expected to occur, since bleach dissociates in hypochlorite salts, and these salts are not volatile. When looking at the inhalation exposure to hypochlorous acid this is also concluded. Inhalation exposure to this compound is assessed as $3.2*10^{-14}$ mg/m^3 when using diluted sodiumhypochlorite solution to clean the kitchen floor and $4.5*10^{-12}$ mg/m^3 when cleaning the kitchen working top with undiluted sodiumhypochlorite solution. It is therefore not expected that inhalation effects will occur.

Oral exposure
The oral exposure following from hand to mouth contact is assessed in paragraph 5.4.2.4 as 0.0155 mg hypochlorite ion for women and 0.0195 mg for men. When considering the fact that the acute toxicity of sodiumhypochlorite solutions is not very toxic, it is unlikely that adverse effects will occur as a result from ingestion of sodiumhypochlorite bleach due to hand-to-mouth contact.

6.4.3 Conclusion

Based on the above displayed information it is concluded that no adverse health effects are expected as a result from exposure to aqueous sodium hypochlorite when it is used for cleaning.

7 Discussion and conclusions

The used methods and the results of this study are discussed in paragraph 7.1. The conclusions are outlined in paragraph 7.2.

7.1 Discussion

In this study exposure and risk are assessed of *one selected compound* per product type during the performance of *one or two tasks* in the *kitchen*. This implies that the conclusion that besides dermal irritation no harm is expected following the use of the studied products, is limited to harm caused by exposure to the selected compounds when completing the selected tasks in the kitchen.

When the compounds were selected for the assessment, no in-depth investigation was performed into the question whether these compounds were the most hazardous ones present in the product. Therefore, the possibility cannot be ruled out that there is another compound or a combination of compounds present in a product that does have the potential to cause adverse effects.
It would have been interesting to include surfactants. However, it was only possible to retrieve what type of surfactant was present in the product. The actual compound itself was impossible to retrieve, as suppliers will not reveal the exact composition of the product. For exposure assessments it is necessary to know the structure of the compound and its characteristics. Therefore surfactants could not be included in this study.

When products are used differently (in a different manner or for different tasks) from what is described in this study, exposure might lead to another exposure level.
Furthermore, it should be kept in mind that hygienic cleaning products used in the kitchen could be used in other areas of the house as well, like in the toilet and the bathroom. Due to this extended use, prolonged use duration and increased use frequency can lead to higher exposure levels.

Besides exposure to the compound following the use of hygienic cleaning products, people can be exposed to the compound via other sources as well. Most compounds present in the selected cleaning products can also be part of other cleaning products, and even of completely different products such as cosmetics. Background concentrations in food and the environment can also contribute to exposure. However, when considering the nature of the potential effects of the compounds (mostly irritation), and the fact that most exposure levels are far below the toxicological no observed effect levels and the limit values, it is not expected that addition of background exposure to the assessed exposure resulting from the use of cleaning products, will lead to other conclusions.

Most parameters needed in the exposure assessments are derived from literature. Weegels (1997) did a study in which 45 people in 28 households reported the use of several cleaning products for a period of three weeks. She also observed 28 people while they did the dishes (Weegels, 1997). Weegels (1998) compared the results of consumer product use of questionnaires, diaries and frequency counters. She concludes that the results of diaries seem to present more reliable data than those of questionnaires (Weegels, 1998). The data gathered by Weegels (1997) by means of diaries are the most reliable data available on the use of cleaning products in Dutch households. Other data presented in literature are gathered by means of questionnaires and do not provide information on use duration, only on product use and amount used (Smit & Visser, 1987), or are based on questionnaires in American households (USEPA, 1987). American households are not completely comparable to Dutch household due to differences in cleaning habits and different measurements of the kitchen. Therefore, Weegels' data were often used in this study. If no information on product use was available, pilot studies were done in order to retrieve data on use.

The goal of the exposure assessments performed in this study is to assess risk. Therefore, the assumptions are such that they would lead to a 'reasonable worst-case scenario'. It was found that information on the concentration of a compound in a product is often provided as a range. If a range was provided, the high-end was used for the exposure assessment. The actual concentration of the compound in the product could be lower.
For the other input parameters 75 percentiles were used. Because of relations between parameters, multiplication of the 75 percentiles will lead to an estimate of exposure in the range of the 95-99 percentile (Bremmer & Van Veen, 1999). The multiplication of two 75 percentiles results in a 93.75 percentile of the result. The calculations in the models in CONSEXPO are based on multiplications of more than two parameters for which 75 percentiles are used as input. Depending on the exact formula and the number of multiplied parameters; the results of exposure estimates are in the range of the 95-99 percentile.

The use of consumer products is characterised by variability. Variability in parameters like use duration, use frequency, the amount of product used, the use of diluted versus undiluted product all influence exposure, implying differences in exposure levels between people.
By means of Monte Carlo analysis it is possible to express variability in parameters in the results. This is accomplished by entering distributions in stead of point values for the input parameters. From these input distributions, 10.000 samples are taken. These samples are at random combined with samples taken from the other input distributions, resulting in a distribution of exposure (Thompson, *et al.*, 1992; Washburn, *et al.*, 1998). Such analyses provide valuable additional information on exposure following the use of cleaning products, as it gives an indication of the influence of variability on the results of the exposure assessments. It results in a range of exposures that occur within the population (Burmaster & Lehr, 1991).
If the point estimates are compared to the distribution of exposure, it becomes clear how the point estimate relates to other possible occurring exposures. However, in order to perform Monte Carlo analysis, sufficient information on the input parameters needs to be available for the formulation of an input distribution.

For exposure to dishwashing liquid, it was possible to perform a Monte Carlo analysis for inhalation exposure based on distributions for release area, use duration and weight fraction of glutaraldehyde in dishwater. From this analysis it is concluded that the point estimate of exposure is approximately within the range of the 95-99 percentile within the distribution. At the highest exposure level of the resulting distribution, no adverse effects are expected. For the other exposure assessments, it was not possible to perform Monte Carlo analysis, because of insufficient data for the provision of input distributions.

Only for bleach containing products is was possible to compare the calculated risk with data from the literature. In literature it is also concluded that during normal use conditions, no adverse effects are expected to occur (Racioppy *et al.*, 1994; AISE, 1997). Furthermore, no comparable studies are reported in literature. In one study exposure was assessed to a compound DGBE (diethylene glucol mono buthyl ether) in a hard surface cleaner (Gibson, *et al.*, 1991). However, since compound characteristics determine for a large part exposure and risks it is not possible to compare Gibson’s exposure levels to any of the exposures calculated in this study.

Dishwashing liquid

For dishwashing liquid, exposure was assessed to glutaraldehyde during dishwashing and when cleaning hands.

In this assessment, it was found that the concentration of the compound in the product is often provided as a range. This can lead to inappropriate conclusions. On the product safety data sheet it was stated that glutaraldehyde was present in a concentration of ‘0-5%’. In a concentration of above 2% however, this substance is known to have sensitising properties on the skin, leading to allergic contact dermatitis (HSE, 1997; NOHSC, 1994). After contacting the supplier of the product, it was revealed that the product contains maximally 0.1% glutaraldehyde. In absence of legislation for cleaning products, they applied a recommendation for cosmetics to dishwashing liquid (P&G, 1999).

The vapour pressure of glutaraldehyde depends on the matrix in which the compound is present (pH, concentration, temperature, other compounds), ranging from 17 mm Hg (pure glutaraldehyde) to 0.0012 mm Hg (2% glutaraldehyde). This is caused by the property of glutaraldehyde to polymerise in aqueous solutions. Although the compound is present in dishwashing liquid in a concentration of up to 0.1%, it is in this assessment assumed that this compound has a vapour pressure of 0.0152 mm Hg (50% aqueous solution). The reason is that ethanol is present in dishwashing liquid which prevents glutaraldehyde from polymerisation. Additionally, glutaraldehyde is added to dishwashing liquid as a preservative. It is not expected that the compound in this solution is volatile since dishwashing liquid is used for a relatively long time period.

The exposure assessment leads to the finding that dermal exposure to undiluted dishwashing liquid when cleaning hands is slightly higher (1.02 mg/cm^3) than the level at which in a human experimental skin sensitisation test, no sensitisation was observed (1 mg/cm^3). In case reports it is described that 2% (20 mg/cm^3) solutions resulted in a development of allergic contact dermatitis.

Based on these data and on the fact that in Australia glutaraldehyde is classified as a sensitiser in concentrations of ≥ 1% (10 mg/cm^3), it is not expected that a sensitisation reaction will occur (NHOSC, 1994). However, it is considered that additional information on the sensitising capacities of glutaraldehyde (in humans) in concentrations between 0.1 and 2% would be valuable.
Based on the exposure assessments and a first screening of toxicity no adverse effects are expected to occur as a result of the use of hygienic cleaning dishwashing liquid.

Hygienic cleaning napkins
Exposure was assessed to isopropylalcohol when cleaning the kitchen working top with hygienic cleaning napkins.
No information was available on the use of hygienic cleaning napkins. Therefore, contact parameters are deduced from those of cleaning the kitchen working top with other detergents. The used scenario for dermal exposure, does not take a decrease in evaporation of the compound from the matrix into account. This has led to an overestimate of dermal exposure to isopropylalcohol, because it evaporates easily from the product. Based on this assessment no adverse effects are expected to occur, therefore it is not expected that adverse effects following dermal exposure are experienced.
Exposure via the inhalation and oral route to isopropylalcohol following the use of hygienic cleaning napkins is neither expected to cause adverse effects on human health.

Hygienic cleaning spray cleaners
Exposure to and risks of DDAC were assessed resulting from the use of hygienic cleaning spray cleaners for cleaning the kitchen working top.
On the use of spray cleaners no information was available besides the use instructions. Therefore, a pilot study was performed to retrieve information on use (e.g. use duration, amount of product used and the way in which a product is used). In this pilot five subjects were used, all in the age between 23 – 36, and working. None of them had ever used the product before. This study was done under test conditions, which may have changed the way in which people performed the cleaning task. In this pilot, it was found that the product was not used according to the use instruction. This can be explained with the fact that only one of five subjects read the product label. This is in consistency with Kovacs *et al.* (1997) who found that very few subjects read the product labels.
This pilot study provided data on which a reasonable estimate of product use could be based. The ideal situation to study the cleaning behaviour of people is to observe people at home that often use the product. However, within the framework of this study this was not feasible.

In CONSEXPO two spray models are available; the spray cloud and the spray well mixed model. Neither of these models perfectly describes exposure to DDAC when using a spray cleaner for cleaning the kitchen working top. The assumption in the spray cloud model that the user has his nose in the cloud overestimates the inhalation of droplets during spraying extremely, since the product is used approximately an arm-length away from the face. Therefore, the spray well mixed model was used.

Only limited information was available of dermal and oral toxicity of DDAC, and none at all for inhalation toxicity. Based on the available exposure and toxicological information we think that exposure to undiluted product could lead to slight dermal irritation in sensitive humans. Other adverse effects following the use of a hygienic cleaning spray cleaner are not expected to occur.

Bleach containing products

For bleach (sodiumhypochlorite) containing products, exposure was assessed to the compounds HOCl via the inhalation route and to OCl^- via the dermal and oral route of exposure following the cleaning of the kitchen working top and the kitchen sink. Additionally, exposure was assessed to diluted bleach containing all purpose cleaner.

In aqueous sodiumhypochlorite solutions, three reactive chlorine species can be present; HOCl, OCl^- and Cl_2 (see equation 1 –3).

$$NaOCl + H_2O \rightleftarrows HOCl + NaOH \qquad (1)$$

$$HOCl \rightleftarrows H^+ + OCl^- \qquad (2)$$

$$HOCl + H^+ + Cl^- \rightleftarrows Cl_2 + H_2O \qquad (3)$$

Chlorine gas (Cl_2) is only formed below pH 4. The pH of the products ranges from 10.5 to 13. It is therefore concluded that no chlorine gas will be present during normal use of these products. At the mentioned pH of the products almost all sodiumhypochlorite will be present as OCl^-. However, when opening a bottle of chlorine bleach, one smells a scent associated with chlorine. Since ions like OCl^- are hardly volatile and not associated with a scent, and since chlorine gas is formed only below pH 4, it is concluded that the scent is caused by HOCl. HOCl is a factor 10^5 more volatile than OCl^-. Therefore, dermal and oral exposure are assessed for OCl^- and inhalation exposure for HOCl.

Again, no adverse effects are expected to occur from the use of bleach containing products for cleaning in the kitchen.

7.2 Conclusions

The aim of this study was:

- to identify the products belonging to the category hygienic products used in the kitchen;
- to examine what compounds are present in these products;
- to examine how people are exposed to compounds in these products during the performance of cleaning tasks in the kitchen;
- whether exposure would lead to health risks.

In this study, a complete overview is provided of hygienic cleaning products available in Dutch supermarkets. The composition of the products was retrieved. Based on the exposure estimates for the selected compounds and the selected tasks, it is concluded that the use of a DDAC containing spray cleaner could lead to slight dermal irritation if undiluted product is contacted. For the other assessed compounds no adverse effects are expected to occur following the use of the products for cleaning purposes in the kitchen.

At this moment a number of new hygienic cleaning products are introduced within the assessed product categories (e.g. a spray cleaner and new all purpose cleaners). Based on the information gathered in this study it is now possible to assess exposure to compounds in these new products relatively easily.

Acknowledgements

In December 1998 I started my student internship at the RIVM. It was the final stage of my studies Environmental Health Sciences at Maastricht University. During this internship I did research on the exposure to and risks of the use of hygienic cleaning products in the kitchen at the division of Exposure Modelling (BM) of the Laboratory of Exposure Assessment and Environmental Epidemiology (LBM).

The methods and results of this study are described in the underlying report. My internship has been a valuable experience for several reasons. It has offered me the possibility to put into practice the knowledge acquired during my studies of Environmental Health Sciences. It also enabled me to deepen my knowledge of exposure and risk assessments in a scientific institute under supervision of experts within this field of interest.

I would like to thank everybody who helped me to succeed. Especially Dr. M.P. van Veen, my RIVM supervisor, Ing. H.J. Bremmer and Dr. M. Zeilmaker, for their valuable comments during the study and when reviewing this report. The discussions we had and their feedback have been very instructive to me.
Additionally I would like to thank my Maastricht University supervisors Dr. H. Albering and Prof. dr. J. Kleinjans for their support during my internship.

Furthermore I would like to thank everybody at LBM who have made my seven months' period there a pleasant one.

Bilthoven, July 13th 1999
Marieke Weerdesteijn

References

A.I.S.E. Technical Task Force HYPOCHLORITE. (1997). Benefits and safety aspects of hypochlorite formulated in domestic products.

Anderson, F.A. (1996). Final Report on the Safety Assessment of Glutaral. A Critical Review of the Toxicology of Glutaraldehyde. Journal of the American College of Toxicology, 15 (2), 98-139.

Beauchamp, R.O., St.Clair, M.B., Fennell, R.F., Clarke, D.O., Morgan, K.T. (1992). Critical Reviews in Toxicology, 22(3,4), 143-174.

BIBRA. (1990). Toxicity Profile Didecyldimethylammonium chloride. Carshalton: BIBRA International.

Bremmer H.J., Van Veen M.P. (1999). Factsheet algemeen, randvoorwaarden en betrouwbaarheid, ventilatie, kamergrootte, lichaamsoppervlak. Bilthoven: RIVM (rep no. 612810 009).

Brittish Occupational Hygiene Society (BOHS) Special Interest Group for the Health Service. (1999). COSHH Guidance on Glutaraldehyde. Internet: http://www.ed.ac.uk/~alfred/glut1.html (retrieved: 22-3-1999).

Burmaster, D.E., Lehr, J.H. (1991) It's time to make risk assessment a science. Ground water monitoring review, summer issue.

Colgate Palmolive (1995). Veiligheidsinformatieblad Ajax 2 in 1 mint frisheid

Consumentenbond. (1998). Het gootsteenkastje, Resultaten van de Doe-mee enquête: De zin en onzin van het gebruik van chloor in het huishouden. 'S-Gravenhage: Consumentenbond (unpublished).

CTB. (1996). Toelating SanaSept desinfecterende spray reiniger (toelatingsnummer 11763N). Internet: http://www.bib.wau.nl/ctb/files_01.html

De Jong, D. (1996). C52.3.2 Alkyldimethylbenzylammoniumchloride, alkyldimethylethylbenzylammoniumchloride, alkyltrimethylammoniumchloride, dialkyldimethylammoniumchloride, didecyldimethylammoniumchloride, dodecyldihydroxybenzylammoniumchloride. (CTB, unpublished)

De Leer, E.W.B. (1987). The origin of Organochlorine Compounds in Drinking and Surface Waters. Delft: Delfts University Press.

ECETOC. (1994). Assessment of Non-Occupational Exposure to Chemicals. Brussels: ECETOC (rep no. 58).

Epiwin: estimation software. SRC-EPI for Microsoft Windows 1997.

EU. (1989). 89/542/EEC Commission Recommendation of 13 September 1989 for the labelling of detergents and cleaning products. Internet: http://www.europa.eu.int/eurlex/en/lif/dat/1989/en_389X0542.html (9-6-1999).

EU. (1991). Commission Directive 91/155/EEC of 5 March 1991 defining and laying down the detailed arrangements for the system of specific information relating to dangerous preparations in implementation of Article 10 of Directive 88/379/EEC. Internet: http://www.europa.eu.int/eur-lex/en/lif/dat/199/en_391L0155.html (9-6-1999).

Falbe, J. (Ed.) (1987). Surfactants in Consumer Products: Theory, Technology and Application. Berlin: Springer-Verlag

Flier, H. (1997). Natriumhypochloriet/bleekloog. In Chemische feitelijkheden: Actuele encyclopedie over chemie in relatie to gezondheid, milieu & veiligheid. 's-Gravenhage: Koninklijke Nederlandse Chemische Vereniging.

Gibson, W.B., Keller, P.R., Foltz, D.J., Harvey G.J. (1991). Diethylene glycol mono butyl ether concentrations in room air from application of cleaner formulations to hard surfaces. Journal of Exposure Analysis and Environmental Epidemiology, 1 (3), 369-383.

Gorman, S.P., Scott, E.M., Russell, A.D. (1980). A Review Antimicrobial Activity, Uses and Mechanism of Action of Glutaraldehyde. Journal of Applied Bacteriology, 48, 161-190.

Grada. (1998). Veiligheidsinformatieblad vloeibaar schuurmiddel met bleek

Hakkinen, P.J. (1999). Personal communication of M.P. Van Veen with P.J. Hakkinen (April 5, 1999).

Hakkinen, P.J. (1993). Cleaning and laundry products, human exposure assessments. In Handbook of Hazardous Materials. Academic Press inc.

Hakkinen, P.J., Kelling, C.K., Callandar, J.C. (1991). Exposure assessment of consumer products: human body weights and total body surface areas to use, and sources of data for specific products. Vet.Hum.Toxicol. 33 (1), 61-65.

Harte, J., Holdren, C., Schneider, R., Shirley, C. (1991). Toxics A to Z: A guide to everyday pollution hazards. Berkeley: University of California Press.

Gezondheidsraad (1994). 1- and 2-Propanol. The Hague: Health Council of the Netherlands (publication no. 1994/24).

HSE (1997). Glutaraldehyde: Criteria document for an occupational exposure limit. Norwich: Health and Safety Executive.

Hulzen press. (1999). SanaSept versterkt de zwakste schakel voedselbereidingsketen. Internet: http://www.hulzen.nl/persservice/persbericht.asp?ID=2.

Klaassen, C.D. (1996). Casarett and Doull's toxicology: The basic science of poisons. New York: McGraw-Hill.

Kovacs, D.C., Small, M.J., Davidson, C.I., Fischhoff, B. (1997). Behavioral Factors Affecting Exposure potential for household cleaning products. Journal of Exposure Analysis and Environmental Epidemiology, 7 (4), 505-520.

Lever Fabergé (1993). Veiligheidsinformatieblad Glorix bleek.

Lever Fabergé (1996). Veiligheidsinformatieblad Jif Active Plus.

Lever Fabergé (1998). Veiligheidsinformatieblad Glorix hygiene doekjes.

Lever Fabergé (1999). Personal communication with dhr. Kielman.

Lever Fabergé (1999b). Veiligheidsinformatieblad Andy plus.

Matoba, Y., Takimoto, Y., Kato, T. (1998). Indoor Behavior and Risk Assessment Following Residual Spraying of *d*-Phenomethrin and *d*-Tetramethrin. American Industrial Hygiene Association Journal, 59, 191-199.

Mosselmans G. (1992). Classification and Labelling of Dangerous Preparations. In Commission of the European Communities CEC, Chemicals Control in the European Community (pp. 17-21). Cambridge: Royal Society of Chemistry.

National Occupational Health and Safety Commission (1994). Priority Existing Chemical No. 3 Glutaraldehyde: Full Public Report. Canberra: Australian Government Publishing Service.

NIA/VNCI. (1995). Chemiekaarten: Gegevens voor veilig werken met chemicaliën. Alphen aan den Rijn: Samson Tjeenk Willink.

Procter & Gamble (P&G). (1998). Product Safety Data Sheet: Dreft Extra Hygiene.

Procter & Gamble (P&G). (1999). Personal communication with dhr. R van de Straat (June 18, 1999).

Proscitech Microscopy & Electron Beam Instrument Supplies. (1997). Material Safety Data Sheet. Internet: http://www.proscitech.com.au/msds/c001.html

Racioppi, F., Daskaleros, P.A., Besbelli, N., Borges, A., Deraemaeker, C. Magalini, S.I., Martinez Arrieta, R., Pulce, C., Ruggerone, M.L., Vlachos, P. (1994). Household Bleaches Based on Sodiumhypochlorite: Review of acute toxicology and poison control center experience. Fd. Chem. Toxic., 32 (9), 845-861.

Richardson M.L., Gangoli S. (1994). The Dictionary of Substances and their Effects. Cambridge: Royal Society of Chemistry.

Rohde, B.L. (1994). Desinfectiemiddelen. In Chemische feitelijkheden: Actuele encyclopedie over chemie in relatie to gezondheid, milieu & veiligheid. 's-Gravenhage: Koninklijke Nederlandse Chemische Vereniging.

Scholtens, B. (1998). Steriele Oksels. De Volkskrant 12 September 1998.

Siderius, P.J.S., Van Haaren, N. (1992). Huishoudelijke Schoonmaakmiddelen onder de loep: Milieuproductonderzoek voor milieu- en consumentenorganisaties. SWOKA.

Smit, D., Visser. P. (1987). Inventarisatie Reinigingsmiddelen: eindrapport. Amsterdam: MILAD.

Terpstra, P.M.J. (1998). Domestic and institutional hygiene in relation to sustainability. Historical, social and environmental implications. International Biodeterioration & Biodegradation, 41, 169-175.

Thompson, K.M., Burmaster, D.E., Crouch, E.A.C. (1992). Monte Carlo Techniques for Quantitative Uncertainty analysis in Public Health Risk Assessments. Human and Ecological Risk Assessment, 12, 53-63.

USEPA. (1987). National household survey of household cleaning products. Washington:USEPA.

Van den Wijngaard, J. (1987). Reinigen, een vak apart. Haarlem: Schuyt.

Van Hoeven, P., Van Leeuwen, R. (1994). RIVM conclusion: Dialkyldimethylammonium-chloride and bromide. In Dialkyldimethylammoniumchloride and bromide. Bilthoven: RIVM/ACT (unpublished).

Van Veen, M.P. (1996). A General Model for Exposure and Uptake from Consumer products. Risk Analysis, 16 (3), 331-338.

Van Veen, M.P., (1997). CONSEXPO 2: Consumer Exposure and Uptake Models. Bilthoven: RIVM. (rep.no. 612810 005)

Versar inc. (1989) Final report Environmental releases of chemicals in household products (for USEPA). Springfield: Versar inc.

Vollebregt, L., De Mooy, R., Van Broekhuizen, P. (1994). De grote schoonmaak totaal vernieuwd: Over de aard, gezondheidsrisico’s en milieu-effecten van reinigingsmiddelen en adviezen voor een veilige en mileubewuste reiniging. Amsterdam: Chemiewinkel UvA.

Vollebregt, L.H.M. (1998). The necessity and environmental and health effects of the (extended) usage of hypochlorite in households. Amsterdam: Chemiewinkel UvA.

Vollebregt, L.H.M., Van Broekhuizen, P.(1994). Tussen wasmand en afdruiprek: Over de aard, gezondheidsrisico’s en milieueffecten van was- en reinigingsmiddelen en tips voor een veilig en minder milieubelastend product. Amsterdam: Chemiewinkel UvA.

Washburn S.T., Kleiman, C.F., Arsnow, D.E. (1998). Applying USEPA Risk Assessment Guidance in the 90s. Human and Ecological Risk Assessment, 4, 245-251.

Webster (1996). The New International Webster’s Comprehensive Dictionary of the English Language: Deluxe encyclopedic edition. Naples: Trident Press International.

Weegels, M.F. (1997). Exposure to chemicals in consumer product use. Delft: TU Delft.

Weegels, M.F. (1998). Doen mensen wat ze zeggen: Over het gebruik van chemicaliën in de huishouding. Huishoudstudies, 8 (1), 31-43

WHO. (1990a). Environmental Health Criteria 103: 2-Propanol. Geneva: WHO.

WHO. (1990b). IARC Monographs on the Evaluation of Carcinogenic Risks To Humans: Chlorinated drinking-water; chlorination by products; some other halogenated compounds; Cobalt and Cobalt Compounds (Volume 52). Lyon: IARC.

Wolkoff, P., Schneider, T., Kildesø, J., Degerth, R., Jaroszewski, M., Schunk, H. (1998). Risk in Cleaning: chemical and physical exposure. The Science of the Total Environment, 215, 135-156.

Appendix 1 The wet fraction of hygienic cleaning napkins

For the determination of the amount of cleaning product in hygienic cleaning napkins, five napkins were weighted. First when taken from the box. The napkins were dried overnight in a stove at a temperature of 100°C. The dry napkins were weighted again. From the difference in weight, the wet fraction in the napkins was determined.

Table 1.1. Weight of hygienic cleaning napkins

	Weight before drying (g)	Weight after drying (g)	'Wet'fraction (g)
1	5.711	2.292	3.419
2	5.508	2.240	3.268
3	5.760	2.310	3.450
4	5.552	2.231	3.321
5	5.711	2.297	3.414
av	5.648	2.274	3.370
sd	0.111	0.036	0.077
75 percentile	5.711	2.297	3.419

The average weight of the napkins when taken from the package is 5.6 g (sd 0.11). The average weight of the (dry) napkin itself is 2.27 g (sd 0.036). From this test it is concluded that the average wet fraction of hygienic cleaning napkins equals 3.37 g. In this study, the 75 percentile was used for the calculations, 3.4 g.

Appendix 2 General overview of used CONSEXPO 3.0 models

The general model framework proposed by Van Veen (1996) is implemented in the computer application CONSEXPO 3.0. This is the tool used in this study to perform exposure assessments. Within the model framework, exposure is separated into contact, exposure and uptake.
Contact defines how long and how often the product is contacted.
Exposure is defined as the concentration of a chemical compound in air, water or some product at the outside of the body (Van Veen, 1996). In CONSEXPO, exposure can be assessed per route of exposure; via the dermal, inhalation and oral route. Per route of exposure various scenarios are developed. The scenario best suitable to product use can be selected in the computer application. After filling in the parameters needed for the assessment (both contact and exposure parameters), exposure is calculated for the relevant routes by means of the selected scenarios (Bremmer & Van Veen, 1999).
CONSEXPO is still under development. New models are developed in order to cope with the whole range of consumer products, and some of the models are being adapted in order to describe exposure better.

2.1 Contact

Without contact there is no exposure. This implies that for all exposure assessments contact needs to be defined. The parameters that define contact are:

- contact frequency;
- total duration;
- use duration.

Total duration is the total duration of contact, whereas duration of use is the actual duration of using the product. These parameters differ when the user is still present in the same area where the product was used after actual use, and when there is still compound present for exposure.

2.2 Exposure models

At this moment, CONSEXPO 3.0 consists of 9 different scenarios to describe inhalation exposure, 6 scenarios for the description of dermal exposure and 5 for oral exposure. Here, the scenarios applicable to hygienic cleaning products will be described briefly.

2.2.1 Dermal Exposure

The dermal exposure scenario applicable to the use of all hygienic cleaning products is the fixed volume scenario.

Fixed Volume

The fixed volume scenario describes dermal exposure from a fixed volume of product that contacts a certain area of the skin. The fixed volume scenario can either be used for a small volume that is for example spilled on the skin, or for a large volume like dishwater. The scenario assumes that the product is well mixed and gradients inside the product do not occur. Exposure is calculated by means of the following formula and parameters.

$$E = \frac{W_f A_p}{V_p D}$$

E = dermal exposure (mg/cm^3)
A_p = amount of product (mg)
D = dilution factor (-)
W_f = weight fraction (fraction)
V_p = volume of product (cm^3)

The volume and the amount of product determine the density of product.

2.2.2 Inhalation exposure

Inhalation exposure occurs when a compound evaporates from a cleaning product during use or when inhaling small droplets of the cleaning product itself when a product is sprayed.
The scenarios available in CONSEXPO 3.0 that can be used for modelling inhalation exposure to compounds when cleaning are: the evaporation from mixture scenario, the painting scenario, the spray well mixed model and the spray cloud model.
It is possible to make a distinction between inhalation exposure of the *user* and exposure of a *non-user*. The user is the person that is actually handling the product. The non-user is not handling the product, but is present in the room where the product is used. A user is assumed to contact the compound in a volume of $5m^3$ around the body. The non-user experiences the whole room volume as the volume in which the compound is present. This distinction is made to take into account that the user is exposed closer to the source, and will experience a more intense exposure before the compound spreads over the entire room volume.

Evaporation from mixture

This scenario defines a situation where compounds evaporate from the product. The evaporation rate is driven by vapour pressure of the compound. It is assumed that evaporation does not influence the initial concentration of the compound in the product. The room is ventilated with clean ambient air, and therefore the concentration of the compound will reach equilibrium. The scenario is derived from Jayock (1994), combined with Raoult's law. It assumes that the product is a binary mixture consisting of the chemical of interest and an averaged chemical, replacing the other chemicals (the matrix).
The parameters needed by this scenario are

- release area;
- temperature;
- room volume;
- effective ventilation rate;
- molecular weight of the matrix (Van Veen, 1997).

This scenario is applicable for the determination of inhalation exposure if the amount of compound in a product is not influenced by evaporation; as would be the case if the compound takes in a large weight fraction and the compound does not evaporate easily. If the concentration significantly decreases due to evaporation, the paint scenario should be used.

Paint Scenario

Like the evaporation from mixture scenario, the paint scenario predicts exposure to compounds evaporating from a mixture applied to a surface. The painting scenario models a finite amount of compound in the mixture, in contrast to the 'Evaporation from mixture scenario'. This implies that evaporation stops when the compound has disappeared from the mixture.
The paint scenario assumes that the paint applied to a surface is divided into two layers. The upper layer exchanges the compound with air, the lower one acts as a store (see Figure 2.1 for a schematic representation).

The parameters used in the model are the following:

- release area,
- product amount,
- weight fraction,
- density of the product,
- layer exchange rate,
- fraction to upper layer,
- room volume,
- effective ventilation,
- room temperature
- molecular weight of the matrix (Van Veen, 1997).

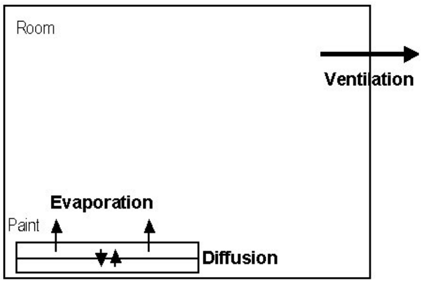


Figure 2.1. Schematic representation of the paint scenario

This scenario is applicable for a cleaning product in which a volatile compound is present, and if the volatility influences the weight fraction of the compound in the product.

Spray Cloud model

For products that are applied by spraying, the spray cloud model can be used for a description of inhalation exposure. The model represents a cloud of aerosol droplets that is released at a certain height and deposits according to droplet size. Ventilation is assumed not to remove any droplets and the compound does not evaporate from the droplets. It is furthermore assumed that the user has his nose in the cloud, until the cloud has deposited completely. The non-user does not experience the cloud until it reaches half the room size (see Figure 2.2 for a schematic representation of the spray cloud model).
The parameters needed for the assessment of exposure with this scenario are:

- the generation rate (amount of product sprayed per unit of time);
- the density of the formulation;
- the weight fraction;
- the airborne fraction;
- the room volume;
- droplet size;
- release height;
- radius of the cloud.

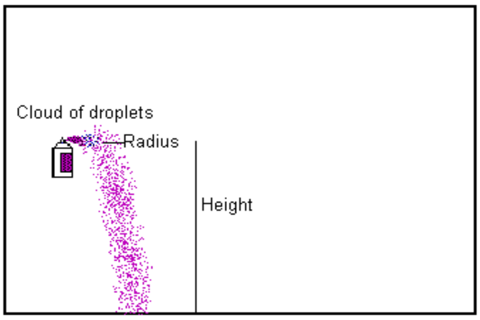


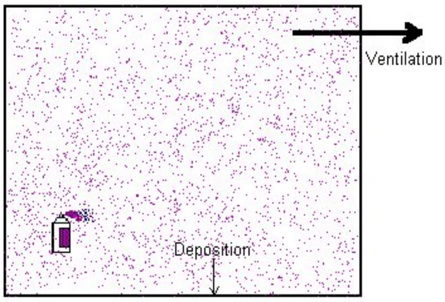
Figure 2.2. Schematic representation of spray cloud model

Spray well mixed model

The spray well mixed model assumes that a spray generates droplets that are homogeneously mixed in the room volume or for the user in the personal volume. Droplets are removed from the room by deposition and ventilation.

It models inhalation exposure resulting from inhalation of the droplets. It does not (yet) take into account inhalation of compound evaporated from the droplets. Therefore, it should be used only when the chemical has low vapour pressure. The model is applicable to products that are applied by spraying, for a product that is used indoors, in a room that is assumed to be well mixed by ventilation (see Figure 2.3 for a schematic representation).

The parameters on which this model depends are:



- generation rate of the product (the amount of product sprayed per time unit during use duration);
- the weight fraction;
- the fraction of the droplets that becomes airborne;
- the ventilation rate of the room;
- room volume;
- droplet size;
- release height.

Figure 2.3. Schematic representation of the spray well mixed model

2.2.3 Oral exposure

Oral exposure during cleaning can occur via hand-to-mouth contact. In CONSEXPO, a hand-to-mouth contact scenario is available.

Hand – mouth contact

The scenario quantifies oral exposure originating from dermal exposure on the hands and subsequent hand-mouth contact. The parameters needed for exposure calculation with this model are concentration and ingestion rate.

However, in the exposure assessments this scenario could not be used due to difficulties in predicting the ingestion rate. Therefore within the framework of this study an extra scenario was defined. In this scenario it is assumed that the amount of cleaning product attached to one square centimetre (a fingertip) of the hand is ingested several times. The number of times is assumed to depend on the use duration. When the product is used for a longer time-period, it is expected that the user touches his lips with his fingertips more often, than when a product is used for a short period of time.

2.3 Compound characteristics

For the calculation of exposure, some compound characteristics are of importance. Volatility of the compound is for example important for the calculation of inhalation exposure with the evaporation from mixture. The compound characteristics needed by CONSEXPO are:

- Molar weight
- Vapour pressure
- Log K_{ow}
- Water solubility

Appendix 3 Release areas

In this appendix it is described how values for release areas are determined. First the derivation of realease area for the kitchen sink is described and secondly those of the kitchen working top and floor.

3.1 Kitchen sink

In this study two different release areas for the kitchen sink are used. When doing the dishes, the release area equals the surface of the sink. When cleaning the sink itself however, the release area consists of all five sides of the sink (See figure 3.1a and b).

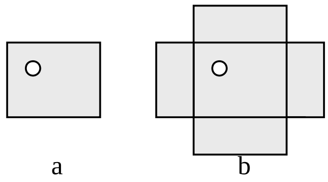


Figure 3.1 a. Release area for dishwashing;
b. Release area for cleaning the kitchen sink

For a determination of the measurements of sinks the pricelist of 'De Franke Huisselectie' was used. In this pricelist, the measurements of 18 sinks were described. In table 3.1 the average release areas are described together with the standard deviation and the percentile distribution.

Table 3.1. Distribution of release areas for dishwashing and cleaning the kitchen sink

	Release area for dishwashing (cm^2)	Release are for cleaning (cm^2)
Average	1434	3868
Sd	57	108
25th percentile	1400	3800
50th percentile	1428	3860
75th percentile	1453	3901
100th percentile	1523	4035

3.2 Kitchen working top and kitchen floor

It is impossible to consider the area taken in by the kitchen floor and the kitchen working top as independent of eachother and independent of the room volume. In the exposure estimates the default as established by Bremmer & Van Veen (1999) was used for the room volume. This implies that for the determination of the kitchen floor and working top this room volume of 15m^3 should be taken into account, since the size and volume of a room are related. The default surface area of the kitchen floor is 6 m^2 (Bremmer & Van Veen, 1999).

The release area when cleaning the floor is smaller than the surface area of the kitchen, because part of the floor is taken in by kitchen cupboards. Usually, these cupboards cover the floor under the kitchen working top. The kitchen working top and the floor are thus related to eachother.
To determine the release areas for the kitchen floor and the kitchen working top, two floor plans of a kitchen of 5.9 m^2 were used. The first floor plan is that of the standard kitchen for a housing project. The second floor plan is the kitchen that was placed in stead of the standard kitchen. The standard kitchen is considered minimal. It consists of three lower kitchen cupboards, a gasstove and a fridge. The kitchen that was placed was more luxureous, and consists of a larger kitchen working top and a built in fridge and gasstove (figure 3.2a and 3.2b for the floor plans)

A

B

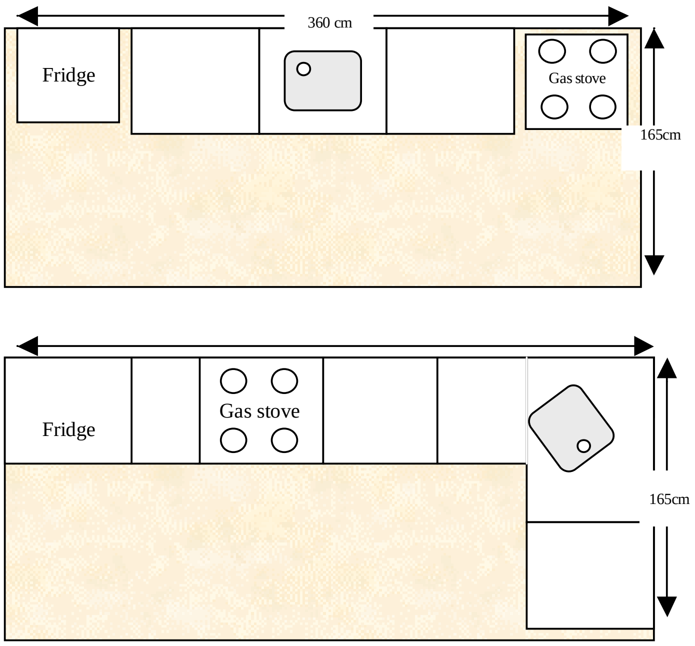


Figure 3.2. Floor plan of kitchen (5.9m^2)

From the floor plans, the following release areas are derived. The release areas in the standard kitchen of 6 m^2 are based on floorplan A, the release areas of the luxureous kitchen are based on floorplan B.

Standard kitchen (A):

	Measurements (cm)	Surface area (cm^2)	
Kitchen working top	210 x 60	12 600	
Kitchen sink (75th perc. See above)		1 452	-
Release area kitchen working top		11 148	

	Measurements (cm)	Surface area (cm^2)	
Measurements kitchen	360 x 165	60 000	
Kitchen working top	210 x 60	12 600	-
Fridge	56 x 49	2 744	-
Gas stove	56 x 55	3 080	-
Release area kitchen floor		41 576	

Luxureous kitchen (B):

	Surface area (cm^2)	
Kitchen working top*	18 600	
Kitchen sink	1 452	-
Release area kitchen working top	17 148	

*Gas stove is not counted

	Measurements (cm)	Surface area (cm^2)	
Measurements kitchen	360 x 165	60 000	
Kitchen furbishment**		27 600	-
Release area kitchen floor		32 400	

**Kitchen working top including fridge, and gasstove

Appendix 4 The amount of water attaching to a hand

As part of the determination of the relevancy of exposure to hand-to-mouth contact, it was tested how much water would attach to a hand after immersing the hand wrist-deep in water. To do so a beaker of one liter was filled with water and placed on a balance. One hand was immersed in the water and taken out without shaking the water off. The weight before dipping the hand into the water and after were measured. This was repeated five times for 1 male and 1 female hand. The results are displayed in table 4.1. The amount attaching to the male hand is significantly higher (α=0.05) than the amount attaching to the female hand. This can be explained by the larger surface area of the male hand.

Table 4.1. The amount of water attached to a hand

	Water attached to male hand (g)	Water attached to female hand (g)
1	3.236	3.075
2	4.158	2.575
3	4.185	2.897
4	4.115	2.570
5	4.088	2.397
av	3.956	2.703
sd	0.40	0.28
75^{th}	4.158	2.897

The amount of water attaching to a square centimeter of the hand

The default surface area of both hands together, hand palm and back of both hands together, is 980 cm^2 for men and 860 cm^2 for women (470 cm^2 for 1 male hand, 430 cm^2 for 1 female hand). The amount of water attaching to one square centimetre of the hand can be calculated based on the 75 percentile value of the amount attached to the hand and the surface area of the hand.

Table 4.2. The amount of water on 1 cm^2 of the hand

	Water attached to hand** (mg)	Default surface area of the hand* (cm^2)	Amount of water (mg/cm^2)
Female	$2.897*10^3$	430	6.737
Male	$4.158*10^3$	490	8.486

* Source: Bremmer & Van Veen, 1999
** 75 percentile (see table 4.1)

The amount of water attached to 1 cm^2 of the male hand and the female hand differ significantly. Differences in the skin like smoothness and dryness of the skin can cause this. The skin of the tested female hand was smoother and less dry than the skin of the male hand.

Appendix 5 The use of hygienic cleaning spray cleaners

5.1 Introduction

Two reasonably new hygienic cleaning products in the form of trigger sprays are available in the supermarkets, 'Glorix hygiene expert keukenreiniger' (Glorix hygiene expert kitchen cleaner), and 'SanaSept desinfecterende sprayreiniger' (SanaSept disinfecting spray cleaner). Since there are no use and exposure data available, a small-scale pilot study was done to gain some more insight in the use of these products, as needed for the exposure assessment of these products. Specific parameters that needed to be retrieved are use duration and the generation rate of the product (the amount sprayed per time unit). The central question was the following:

How are the products Glorix hygiene expert kitchen cleaner and SanaSept disinfecting spray cleaner used for cleaning an area of 60x60 cm of the kitchen working top?

5.2 Materials and Methods

Subjects

A number of five volunteers of the 'Laboratory of Exposure Assessment and Environmental Epidemiology' have participated in this pilot study.

- Subject 1: female, 23 years
- Subject 2: male, 36 years
- Subject 3: female, 30 years
- Subject 4: male, 33 years
- Subject 5: female, 36 years

Task

The subjects were all asked to pretend that the marked area on the table was the area on their kitchen working top where they had prepared chicken. They want to hygienic clean the area; first with SanaSept disinfecting spraycleaner, secondly with Glorix hygiene expert kitchen cleaner. The area to be cleaned was 60x60 cm and was marked with tape.
The items that were available for completing the task are listed below. It is specifically mentioned that they could use all items including the tap with running hot and cold water.

- Small bucket
- Tap with hot and cold water
- Kitchen paper
- New cotton cloths
- 1 bottle of SanaSept hygienic cleaning spraycleaner
- 1 bottle of Glorix hygiene expert kitchen cleaner

Observations

Two people observed the subjects while performing the cleaning task. One observer registered the duration of the stages of the cleaning process (spraying, leaving on, cleaning / rinsing). The second observer measured the amounts used by weighing the amount of product in the bottle before and after use. Secondly, she registered how the subjects used the products. Attention was paid to how the stages were performed in general and more specifically to:

1. reading of instructions for use;
2. product use including: items used for the task, rinsing of cloth, washing of hands after completing cleaning task;
3. the amount of product used and the number of times of triggering.

5.3 Results

According to the use instruction, SanaSept should be used by spraying the product onto the surface. Hereafter, the product should be left on the surface to soak in for 5 minutes. After these five minutes, the product should be rinsed or taken off with a clean wet cloth.
The use instruction of Glorix hygienic cleaning kitchen cleaner is very much alike that of SanaSept. A difference is that a distinction is made between cleaning a larger and a smaller surface. For cleaning a smaller surface, the product can be sprayed directly onto a damp cloth and the surface or item can be taken off with this cloth. Another difference is that no exact recommendation for duration of the phase of leaving on to soak in is given (leave on for ‘a while’).

Reading the use instruction

Although none of the subjects used the product before, only subject 1 read the instructions before use. This could also be noticed when observing the cleaning tasks. One other subject, subject 3 looked at the instructions, but in the completion of the task, this could not be noticed. A third person, subject no 4, did look at the front label, but did not read the instructions on the back of the bottle.

Product use

All subjects but one sprayed both products directly onto the surface to be cleaned. Subject 1, sprayed SanaSept directly onto the surface, Glorix however she sprayed directly onto the cloth with which the surface was cleaned. Only one subject, subject 1, left SanaSept on the surface to soak in for a while. Hereby she mentioned that in a real situation she would probably leave the product to soak in longer, for approximately 5 minutes.
When cleaning the area after spraying, only 2 out of 5 subjects rinsed the cloth with water several times when taking off. Of the other 3, 2 cleaned the area with a clean dry cloth, and 1 with kitchen paper. The use instructions of both products indicate that the surface should be rinsed or cleaned after use with a damp cloth. Only one of the persons washed his hands afterwards.

Amount of product used & number of times triggering

The amount of product used by each subject can be found in Table 5.1. The average amount used is 3.86 g (sd 1.04) for SanaSept and 2.84 for Glorix (sd 0.67). There is no statistical difference between the amount Glorix and SanaSept used to clean the surface (Students t-test; p 0.06). All subjects sprayed SanaSept directly onto the surface. All subjects but one (subject number 1) sprayed Glorix onto the surface until most was covered with the product. It is noticed that all subjects but subject 1 use less Glorix than SanaSept (see Figure 5.1). Subject 1 is also the only subject that used Glorix by spraying the product directly onto the cloth in stead of spraying it onto the surface.

Table 5.1. Amount of product used; number of times of triggering; amount per trigger.

	Amount SanaSept used (g)	Amount Glorix used (g)
1	2.395	2.55
2	4.048	3.615
3	3.247	1.993
4	4.776	3.419
5	4.815	2.635
av	3.8562	2.8424
sd	1.037828	0.666965

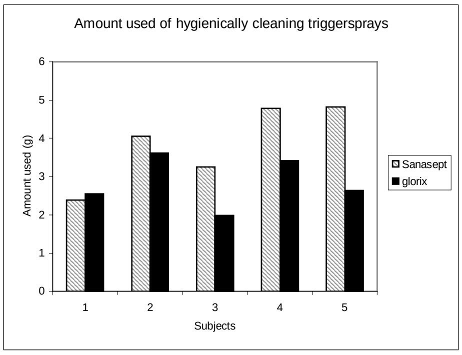


Figure 5.1. The amount of SanaSept and Glorix used for the cleaning task

Duration of phases

The duration of the phases (spraying, leaving on, rinsing) as well as the total duration of the task is described in table 5.2.

Table 5.2. Duration of phases

	Phase 1 Spraying (s)		Phase 2 Leave on (s)		Phase 3 Rinsing / taking off (s)		Total duration (s)	
	SanaSept	Glorix	SanaSept	Glorix	SanaSept	Glorix	SanaSept	Glorix
Subject 1	5	5	33*	X	14	11	52	16
Subject 2	3	2	X	X	7	7	10	9
Subject 3	5	2	X	X	17	15	22	17
Subject 4	5	4	X	X	15	14	20	18
Subject 5	5	6	9	1	26	94	40	101
AV	4.6	3.8	21		15.8	28.2	28.8	32.2
SD	0.89	1.789	16.97		6.83	36.91	16.88	38.62
Use instructions	?	?	300 s (5 min)	? 'a while'	?	?		

X Not left on the surface to soak in
* While completing task: mentions that when using product for real, subject would leave the product on for approximately 5 minutes, according to the use instructions
? Use instructions do not specify duration of phase

Generation rate

One of the parameters needed for an exposure estimate with CONSEXPO is the generation rate (mg/min) of the formulation. The generation rate can be determined from the duration of the first phase spraying, and the amount of product used (see Table 5.3).

Table 5.3. Generation rate SanaSept & Glorix

		1	2	3	4	5	Average	Sd
SanaSept	Amount used (mg)	2395	4048	3247	4776	4815	3856.2	1037.8
	Duration of spraying (s)	5	3	5	5	5	4.6	0.89
	Generation rate (mg/s)	479	1349.3	649.4	955.2	963	879.19	334.21
Glorix	Amount used (mg)	2550	3615	1993	3419	2635	2842.4	666.97
	Duration of spraying (s)	5	2	2	4	6	3.8	1.789
	Generation rate (mg/s)	510	1807.5	996.5	854.75	439.17	921.58	547.05

5.4 Discussion

The best method to study the way in which people use cleaning products is to observe people that use the product regularly in their home environment several times. However within the scope of the underlying study this was not feasible.

The fact that none of the subjects used the product before and the fact that four out of five subjects did not read the use instructions lead to the finding that these four subjects did not use the product according to the use instruction. The people that did not use the product before are expected to use the product in the same manner as they use a different product that is used in the same way like Glassex, although that product is used for differing purposes.
For the spraying phase this is not expected to lead to a differing way in which the product is used. For the leaving on and rinsing/cleaning phase this might have led to bias. hygienic cleaning products are supposed to be left on a surface to soak in for a while in order to reduce the number of micro-organisms, and surfaces are advised to be rinsed or cleaned with a wet cloth. It is expected that if people buy the product they do so to clean hygienic and therefore will more often read the use instruction.

The fact that the surface was not really stained in the test, and the subjects were asked to pretend that it was the area of the kitchen working top where they had prepared chicken, might have led to a differing manner of cleaning than they would have done when the area was really dirty. However, when observing the subjects during the cleaning task, they did so thoroughly and it is not expected that the task would have been done in an entirely different way at home.
Another possible source of bias is that the subjects were observed by two people. This might have led to differing product use because of socially desirable behaviour.

For the exposure assessment it is chosen to linearly extrapolate the use duration of and the amount used during the phase of spraying to cleaning the kitchen working top. For the leaving on phase, the use instruction of SanaSept was used to determine the use duration, with a recommended duration of the phase of 5 minutes. The cleaning and rinsing phase is also linearly extrapolated from the pilot. It is in the extrapolations assumed that the duration of these phases and the amount used is directly related to the size of the area that is cleaned.

Appendix 6 Mailing list

1 Directeur-Generaal Volksgezondheid
2-6 Directie Gezondheidsbeleid
7-11 Inspectie Gezondheidsbescherming
12 ir. P.C. Bragt, Inspectie W&V, VWS
13 dr. H. Roelfzema, Directie GZB, VWS
14 mr. J.A.M. Whyte, Directie GZB, VWS
15 Voorzitter Gezondheidsraad
16 Depot Nederlandse Publikaties en Nederlandse Bibliografie
17 Directie RIVM
18 dr. H.J. Albering, Universiteit Maastricht, GRA-T
19 dr. W. ten Berge, DSM, Heerlen
20 dr. H. E. Falke, CTB, Wageningen
21 dr. K. Gutschmid, IPCS, Geneva
22 dr. G. Heinemeyer, BgVV, Berlijn
23 dr. J. van Hemmen, TNO, Zeist
24 prof. dr. J.C.S. Kleinjans, Universiteit Maastricht, GRA-T
25 dr. C. Lally, Procter and Gamble, Strombeek-Bever
26 dr. R. Luijk, Consumentenbond, Den Haag
27 dr. C. D. Money, Esso
28 dr. G. Moore, KemI, Solna
29 dr. A. Phillips, HSE, Bootle
30 mw. W.M. Blom, CSR
31 ing. H.J. Bremmer, LBM
32 dr. ir. J.G.M. van Engelen, CSR
33 drs. P.H. van der Hoeven, CSR
34 dr. ir. E. Lebret, LBM
35 dr. W.H. Könemann, CSR
36 ir. J.J.G. Kliest, IEM
37 dr. J. Meulenbelt, NVIC
38 dr. ir. G. de Mik, S3/4
39 dr. A. Opperhuizen, LEO
40 dr. ir. M.N. Pieters, CSR
41 dr. M.T.M. van Raaij, CSR
42 dhr. G.M. Steentjes, LBM
43 drs. E.H.F.M. Straetmans, CSR
44 drs. T.G. Vermeire, CSR
45 drs. I. de Vries, NVIC
46-49 Auteurs
50 SBD/Voorlichting & Public Relations
51 Bureau Rapporten registratie
52 Bibliotheek RIVM
53-73 Bureau Rapportenbeheer
74-84 Reserve exemplaren