INFORMATION

Cases of Poisoning Reported by Physicians

2008

BfR

Risiken erkennen – Gesundheit schützen

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Cases of Poisoning Reported by Physicians 2008

Centre for Documentation and Assessment of Poisonings at the Federal Institute for Risk Assessment – 15th Report (2008)

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Preface

Professor Dr. Dr. Andreas Hensel

Dr. Axel Hahn

Dear Reader,

On 1 August 1990, the German Chemicals Act requiring the compulsory reporting of poisonings by attending physicians, came into force. This represented a marked improvement and strengthening of the reporting system on the adverse effects of drugs in Germany. The objective and purpose of the Chemicals Act is to receive from acting physicians well documented findings related to cases of health impairment in humans from exposure to chemical products. The documentation of accidents involving chemical products serves to provide valuable data on incidences of such poisonings, doses and effects of chemicals as well as on formulations of the products involved. On the basis of such data, effective measures of prevention and therapy can be developed at a very early date. In this regard, it has been the specific purpose of legislation that assessment of chemical substances should not rely on toxicological data from animal studies only. Rather, health assessment should, to the maximum extent possible, be based on data from poisoning accidents that continue to occur in humans.

For 18 years, "Cases of Poisoning Reported by Physicians" have been documented at the BfR in close cooperation with attending physicians and the German Poison Control Centres and specifically evaluated with regard to human health. The reports on these cases have been published at annual intervals (since 2004, also in English), and they have met with a very affirmative response owing to their topicality with regard to toxicological issues, their proposals for therapy and preventive measures and consistent presentation of individual case reports.

In the present 15th Report by the Centre for Documentation and Assessment of Poisonings, a subject has again been brought forward which refers to a risk that was well known in the past but nowadays would seem to have fallen into oblivion, namely, cases of poisoning from carbon monoxide in indoor environments, which were found to be on the increase. For the first time, eleven cases were reported where

adults and children had suffered health damage from indoor operation of charcoal grills in their homes. The present report describes, in an exemplary way, causes, consequences and possible medical measures to be taken in the event of accidents involving high numbers of persons. This refers both to chemical accidents in schools and industrial accidents in the chemical industry.

Professor Dr. Dr. Andreas Hensel
President of the Federal Institute for Risk Assessment

With its regular annual report, "Cases of Poisoning Reported by Physicians", the BfR has made an important contribution to risk assessment, based on well documented cases of health impairment in humans caused by chemical substances and products. In this respect we thank attending physicians, Poison Control Centres and also the general public and also ask for their active support in the future.

Dr. Axel Hahn
Head of Unit
Product and Poison Documentation – Centre for Documentation and Assessment of Poisonings

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1 Introduction

1.1 Legal basis and activities of the Centre

With the Chemicals Act (ChemG), legislation in the Federal Republic of Germany has provided a basis "to protect humans and the environment from harmful effects of dangerous substances and preparations, particularly to make them recognizable, to avert and to prevent the development of such effects" (§ 1).

Data on human toxicology that are obtained from the evaluation of cases of poisoning in humans are especially important for a realistic assessment of risks for human health. This is why legislation has introduced compulsory reporting of poisonings from 1 August 1990, by the first amendment to the ChemG (§ 16e). A physician who is consulted for treatment or evaluation of sequelae of diseases caused by chemical substances or products is obliged to submit essential data on poisonings to the Centre for Documentation and Assessment of Poisonings at the Federal Institute for Risk Assessment (BfR).

According to the Chemicals Act, reporting refers to illnesses or suspected poisonings as well as unintentional exposures that are associated with the following substances:

- Chemical substances and products used in the household, e.g. detergents and cleaning agents, hobby and DIY articles;
- Cosmetics
- Detergents and cleaning agents;
- Pesticides;
- Plant protection products;
- Wood preservatives;
- Chemicals used at the workplace;
- Harmful chemical substances found in the environment, also after industrial accidents;
- Plants;
- Animals.

Within the meaning of the Chemicals Act, the term of poisoning designates all cases in which health impairment has occurred, including suspected cases of poisoning. Health impairments in the sense of adverse effects or allergic reactions occurring during or after the common use of a product are also to be reported to the BfR, irrespective of its proper or improper use. The BfR may also be informed of accidents involving a suspect product which did not result in any health impairment. Information on asymptomatic accidents associated with documented exposure may provide useful information with regard to the risk associated with a product.

Under the Act, also the poison information and treatment centres (Poison Control Centres, PCCs) are subjected to compulsory reporting of their knowledge of general importance so that trends may be identified and considerations made with regard to prevention.

1.2 Approach to reporting

Each year, the BfR receives more than 4000 reports by physicians on health disorders and cases of poisoning, including suspected cases. Most of these reports are received from the Berufsgenossenschaften (German professional insurance bodies). The reports are assessed as to the degree of severity of cases, causal relationship, etc. and recorded in a database for evaluation purposes. Of course, the reports should provide all information required for encoding and database input. So far, such information has been submitted on special reporting forms that are quite time-consuming to complete and in their majority do not provide all data required. To avoid a loss of information, it has therefore been recommended to submit the anonymized medical report to the BfR by fax (Fax-No. +49 (0) 30-18412 3929) or in electronic form. If no medical report is available, the

reporting form should be filled in completely and submitted to the BfR. When completing the reporting form it is imperative to take care that the toxicant and/or product name are stated correctly and that information is given on the portal of entry (oral, inhalational, dermal), the history with regard to the circumstances of the accident, site of exposure (workplace or private sphere) and the duration of exposure (acute/chronic). In addition, information should be provided on manifestations, therapy and approach (outpatient/inpatient treatment) and the course and outcome (recovery, late sequelae, etc.). To exclude duplicate reports, it is helpful to provide the patient's date of birth because the patient's name must not be stated for reasons of data protection.

This will make a valuable contribution to complete data sets and meaningful evaluation.

1.3 Processing of reports received

The reports received on health impairments associated with chemicals are subjected to an assessment procedure. This assessment serves to classify the causal relationship between the toxicant involved and the manifestations observed as "possible", "probable", "confirmed", "absent" or "cannot be assessed". The rules applied in the assessment of individual cases have been described in detail in earlier annual reports.

The estimation of toxic risks in humans is based on differentiated analyses and assessments. For these purposes, the data on cases in humans are continuously documented in the form of case data sets and case reports. Information on identified risks is passed on to the responsible ministries, manufacturers and industrial associations in the form of rapid communications or to the manufacturers in the form of summarizing annual reports by means of the product information system PRINS (see Section 2.3). The responsible manufacturers or distributors are requested to transmit to the BfR information on the measures envisaged by them to improve product safety.

The BfR publishes annual reports on the knowledge gained under the title, Cases of Poisoning Reported by Physicians. These annual reports and other publications are available on request by writing to Pressestelle, Bundesinstitut für Risikobewertung, Thielallee 88-92, 14195 Berlin, Germany. They have also been published on the internet (www.bfr.bund.de).

In Fig. 1, the terms of reference and the procedures involved are shown in graphical form.

1.4 Product database (poison information database)

1.4.1 Figures

Until late December 2008, documents on 70 901 products were recorded in the poison information database maintained by the BfR, which can be accessed by the Poison Control Centres (PCCs) in Germany, thus supporting their activities in providing consultation and treatment in cases of poisoning. Thus, the number of reports on products increased by 10 247 in 2008. The structure of the database and the different types of product data sets have been described in detail in earlier reports. The total number of products is lower than in previous years because from early 2008, the cosmetics data sets are directly distributed to the PCCs by the Federal Office of Consumer Protection and Food Safety (Bundesamt für Verbraucherschutz und Lebensmittelsicherheit – BVL), as already mentioned in the last annual report.

1.4.2 Collaboration between the BfR, industry and Poison Control Centres

Of the dangerous preparations and biocidal products reportable under §16e para 1 of the Chemicals Act, and the products reportable under the Detergents and Cleaning Agents Act (WRMG), 36 082 product data sets were forwarded to the PCCs until the end of 2008.

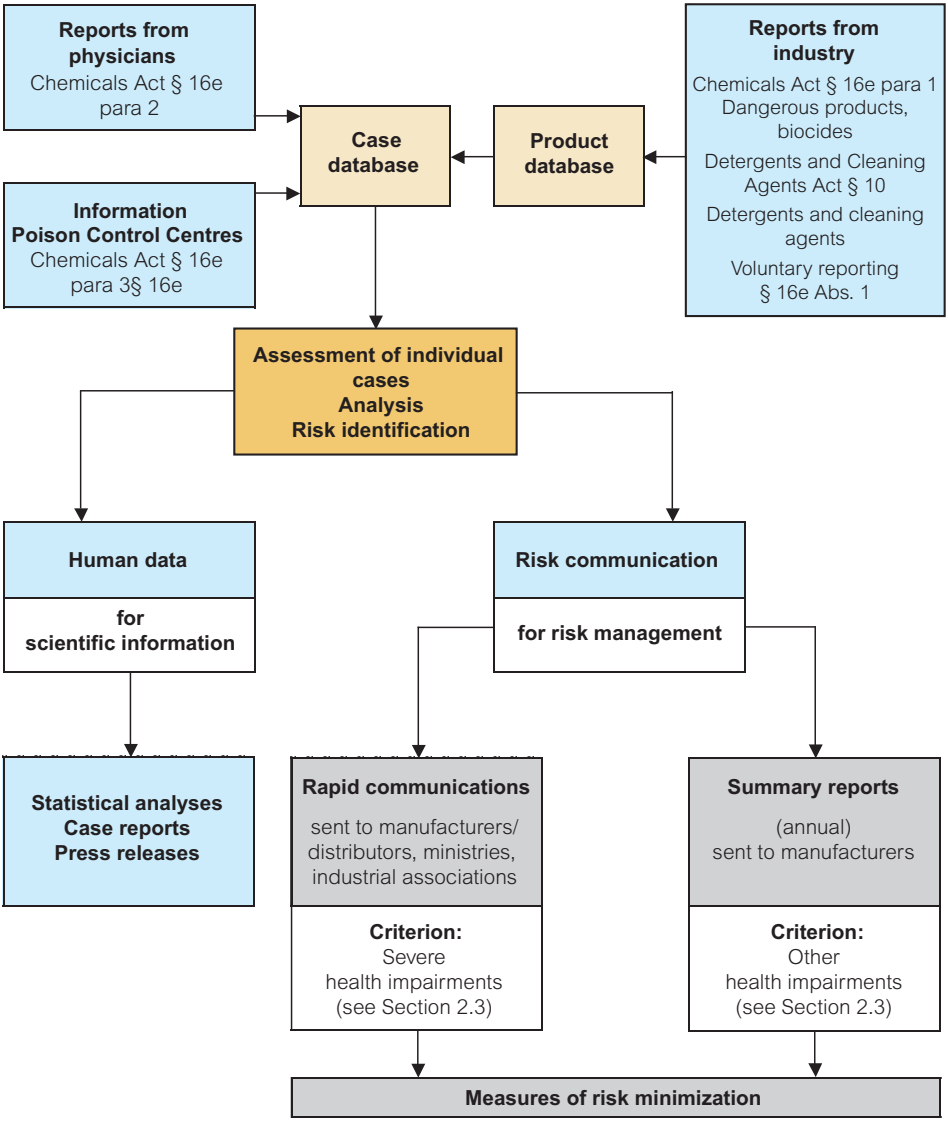


Fig. 1: Terms of reference of the Centre for Documentation and Assessment of Poisonings

Of these, 8 725 referred to dangerous preparations, 11 565, to biocides and 15 792, to detergents and cleaning agents. In addition, 34 819 products reported on a voluntary basis were transmitted to the PCCs.

The major part of product data on dangerous preparations and biocidal products as well as of the voluntary reports by manufacturers, distributors and importers received by the BfR is still submitted on forms. The data to be reported

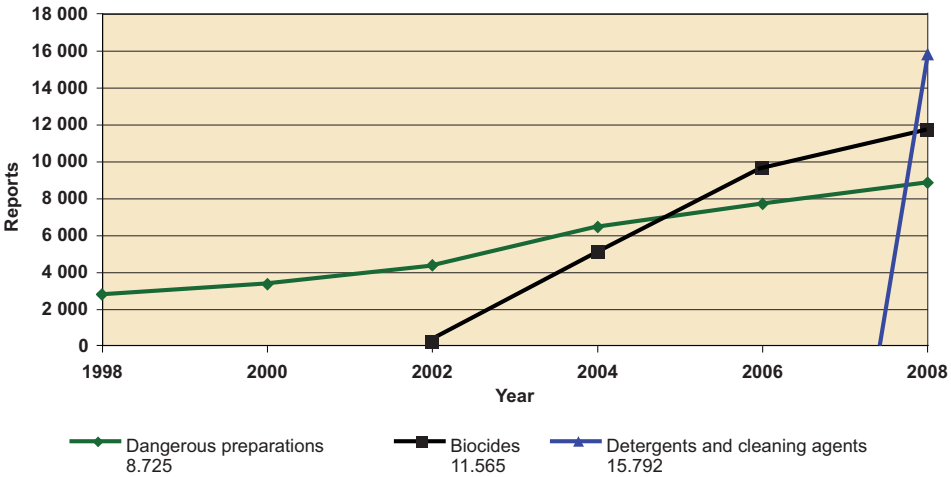


Fig. 2: Development of reports legally required under § 16e para 1 of the Chemicals Act: Dangerous preparations, and biocidal products (Regulations on Biocides, entry into force in 2002), as well as detergents and cleaning agents (Detergents and Cleaning Agents Act, entry into force in 2007)

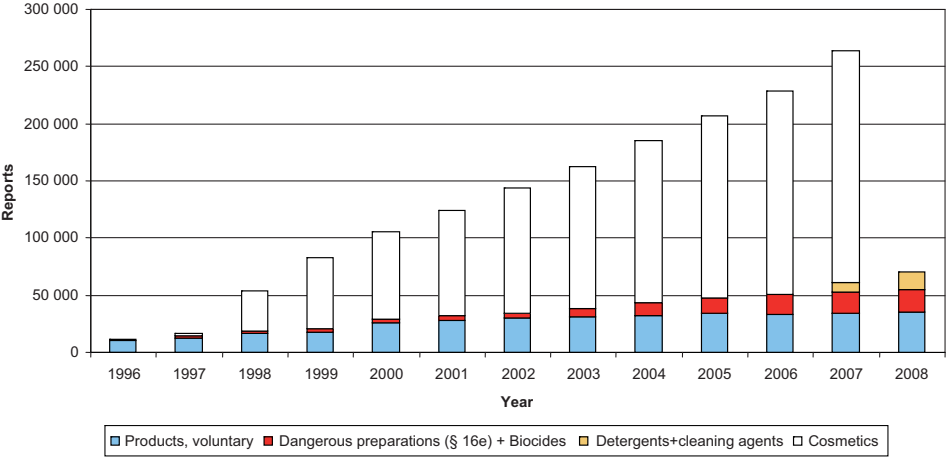


Fig. 3: Reports on products received since 1996 and transmission of information to the German Poison Control Centres

under the WMRG (in effect since 5 May 2007) are submitted by file transfer in XML format. These data as well as all other product data are edited by the BfR, using well established methods, for transmission to PCCs to provide emergency advice.

1.5 BfR proposal for unequivocal identification of products from labelling data

The BfR has already reported on the standardization at the European level (CEN) for unequivocal product identification on labels, which entered into force in October 2007. Based on this CEN standard, the BfR has proposed, for

a better identification in the future, a uniform identification element starting with the i symbol followed by a 5-digit BfR company code, a 5-digit formulation code to be assigned by the manufacturer and the official hazard symbol (see Fig. 4).

ⓘ-<BfR company code>-<product code>-GHS-Code>

BfR company code: 5 digits with leading zero
Product code: 5 digits with leading zero, assigned by the company
GHS code: 2 digits, 00 no label, 99 at least one label
GHS encoding is only necessary if GHS labelling on the packaging is legally required

Examples of product identification labelling
Example 1, if **no** GHS labelling is required on the packaging

ⓘ**-00123-00002-GHS00**

Example 2, if **at least one** GHS labelling is shown on the packaging

ⓘ**-00123-00002-GHS99**

The underlying European Standard (EN 15178) is available from Beuth Verlag (ca. € 50):
Beuth Verlag GmbH , Burggrafenstraße 6, 10787 Berlin, Germany
Phone +49 (0) 30 2601-0, Fax +49 (0) 30 2601-1260

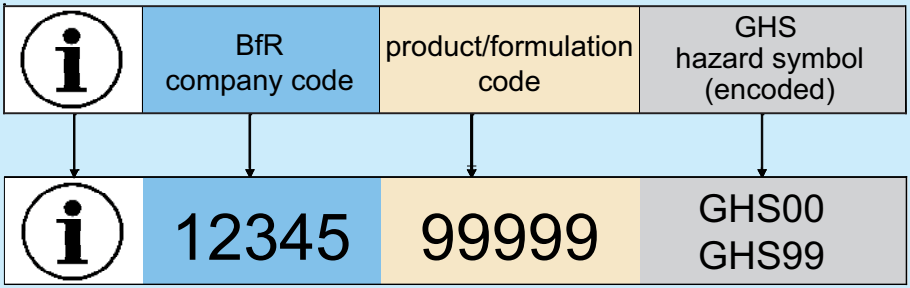


Fig. 4: BfR proposal for a uniform identification

In the interest of consumers and worried parents, the BfR hopes that manufacturers and distributors will implement these proposals without delay so that the PI labelling can soon be used for a fast and unequivocal identification of products involved in cases of poisoning and for risk minimization.

2 Case reports by physicians

2.1 Evaluation of reports

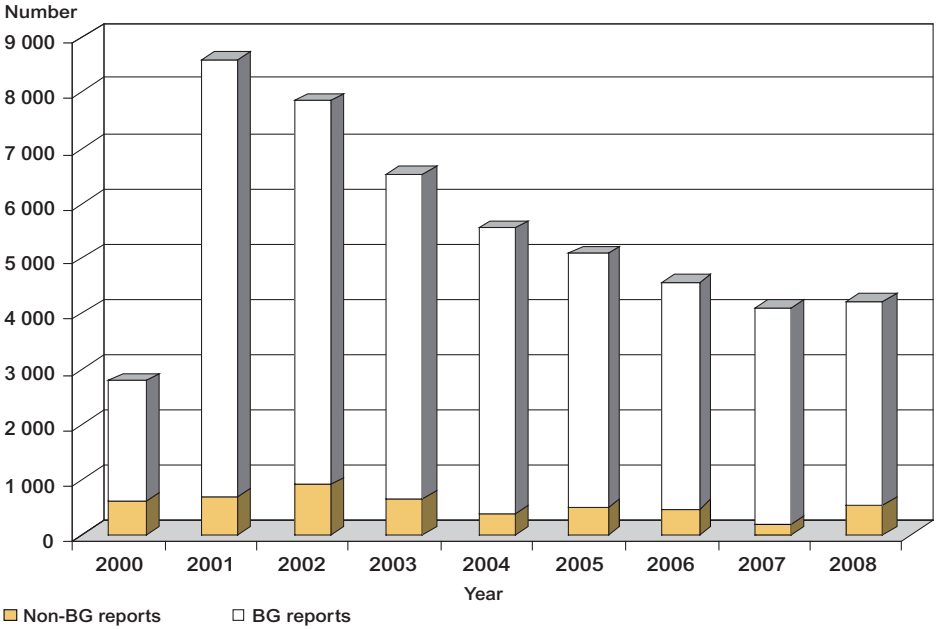


Fig. 5: Cases reported (BG reports 100% = 3 679; non-BG reports 100% = 531) BG: Berufsgenossenschaften – institutions for statutory accident insurance and prevention for trade and industry in Germany

During the period between 1 August 1990, i.e. the beginning of the compulsory reporting, and 31 December 2007, altogether 57 008 reports on cases of health disturbance, poisoning or suspected cases of poisoning were received by the BfR. In the reporting year of 2008, the BfR Centre for Documentation and Assessment of Poisonings received 4 210 reports (see Fig. 5). According to an agreement with the Berufsgenossenschaften made in 2000, all cases of acute health impairment after contact with chemicals or chemical products are reported to the BfR. Since 2001, a continuous decrease has been observed in the number of reports by the Berufsgenossenschaften. According to the BG-Institute for Occupational Safety and Health (Berufsgenossenschaftliches Institut für Arbeitsschutz – BIA), this decrease can be attributed to an actual reduction in the number of accidents, and not to changes in the reporting behaviour. This is caused by prophylactic campaigns informing about circumstances and prevention of accidents, an improved occupational safety and accident prevention due to more effective safety measures and changes in operational processes (in part also automation).

Evaluations by the PCCs have shown that the share of health impairments after intake of or contact with chemical products, household chemicals, plant protection and pest control products and all other reportable product groups has remained high and does not

correspond to the number of reports received by the BfR. This is why the BfR has commissioned a scientific comparison of the data from a PCC with those from the BfR in the context of an MA thesis. Results will be presented in the next annual report.

2.2 Reports on cases of poisoning in 2008

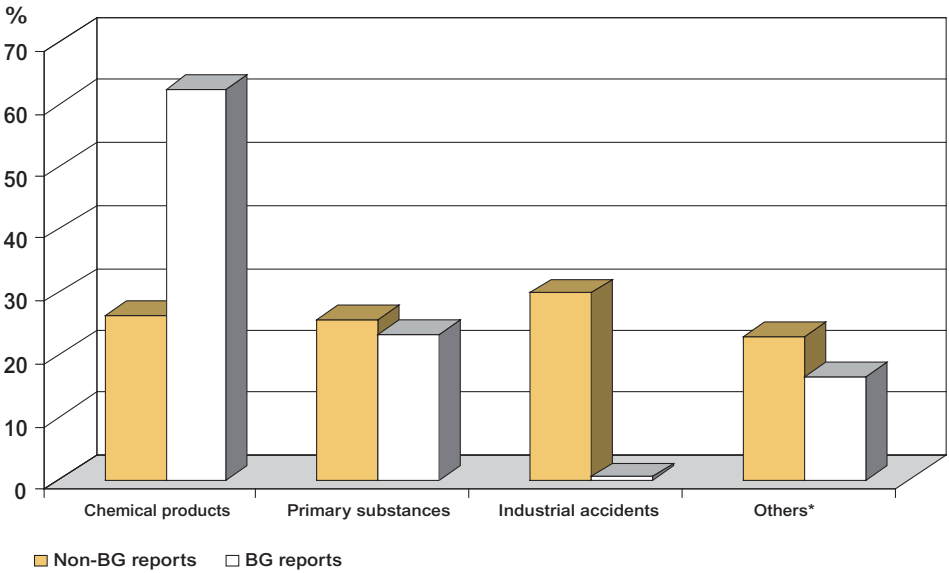
2.2.1 Origin

In 2008, 3 679 cases, i.e. 87.5 % of all cases reported, were reported by the Berufsgenossenschaften. The remaining 531 reports (12.5 %) were essentially submitted by hospitals, medical practitioners and PCCs.

2.2.2 Spectrum of cases reported

Fig. 6 provides a synoptic view of the spectrum of product groups involved in the cases reported. Among the cases reported by the Berufsgenossenschaften, those of poisoning from chemical products and primary substances have remained in top position. All other product groups played a minor role, with shares of 5.8 % each, or less. As expected, the spectrum of substances and products involved in cases of poisoning is different in the reports received from the Berufsgenossenschaften and in those received from hospitals and medical practitioners. Also among the latter, reports related to chemical products ranked first in the reporting year. These are followed by industrial accidents, where events involving a great number of persons affected played a special role. At a clear distance, the next group in ranking is that of primary substances. These are followed by health impairments from foods and beverages, pesticides and medicinal products. Also the latter are received and processed by the BfR although not subject to compulsory reporting.

For a detailed list in tabular form of toxicants reported since the beginning of compulsory reporting in 1990, see Annex. In this table, the



* Others: Medicinal products, foods and beverages, pesticides, cosmetics and personal hygiene products, plants, fungi, animals, veterinary medicines, agrochemicals, narcotic drugs, warfare/anti-riot agents, miscellaneous

Fig. 6: Spectrum of cases reported

	BG reports (100 % = 3 679 reports)		Non-BG reports (100 % = 531 reports)	
Chemical products	62.3 %	(2 293 cases)	26.2 %	(139 cases)
Primary substances	23.1 %	(849 cases)	25.6 %	(136 cases)
Medicinal products	5.8 %	(215 cases)	4.3 %	(23 cases)
Pesticides	3.3 %	(123 cases)	2.6 %	(14 cases)
Cosmetics/personal hygiene products	1.5 %	(57 cases)	3.6 %	(19 cases)
Foods and beverages	0.6 %	(22 cases)	6.8 %	(36 cases)
Agrochemicals	0.6 %	(21 cases)	0 %	(0 cases)
Industrial accidents	0.5 %	(18 cases)	29.8%	(158 cases)
Veterinary medicinal products	0.1 %	(3 cases)	0.8 %	(4 cases)
Warfare/anti-riot agents	0.3 %	(11 cases)	0 %	(0 cases)
Plants	0.1 %	(2 cases)	1.1 %	(6 cases)
Animals	0 %	(0 cases)	0.6 %	(3 cases)
Narcotic drugs	0 %	(0 cases)	1.7 %	(9 cases)
Fungi	0 %	(0 cases)	0.4 %	(2 cases)
Miscellaneous	4.1 %	(150 cases)	0.9 %	(5 cases)

Table 1: Spectrum of reports – synoptic view (repeat listing of toxicants per case possible)

cases have been classified by product application groups (assignment of toxicants according to their intended use).

2.2.3 Circumstances of poisoning

The Berufsgenossenschaften almost exclusively reported cases of exposure to poisons in the context of occupational accidents (ca. 99 % of cases). The remaining 1 % of cases referred to accidents that had occurred during the common use of a product or because a chemical had been mistaken for another substance, or the circumstances of the accident were unknown.

Among the reports submitted by hospitals and medical practitioners, cases of accidental poisoning predominated (66 %), followed by exposure during common use (14 %). Exposure due to mistaking chemicals for other substances was the cause in 3 % of cases, suicidal actions were reported in 3.5 % of cases. 5.5 % of cases were associated with the abuse of substances. In the remaining cases, causes remained unknown.

2.2.4 Age structure and sex distribution

In 2008, the share of cases referring to adults among the total of cases reported was 97.2 %. The share of cases in adults predominated also among the reports received from hospitals and medical practitioners. However, the share of children in these cases was as high as 14 % (see Table 2).

The eight accidents involving children that were reported by the Berufsgenossenschaften occurred in schools.

2.2.5 Degree of severity of health impairment

The medical evaluation of the degree of severity of health impairments is based on the Poisoning Severity Score[1]. In 2008, the majority of cases reported referred to minor health impairment only, both among the cases reported by the Berufsgenossenschaften and among those reported by hospitals and medical practition-

1 Hans E. Persson †, Gunilla K. Sjöberg , John A. Haines and Jenny Pronczuk de Garbino; Poisoning Severity Score. Grading of Acute Poisoning; Clinical Toxicology; 1998, Vol. 36, No. 3, Pages 205-213

	BG reports (100 % = 3.679 reports)		Non-BG reports (100 % = 531 reports)	
Children	0.2 %	(8 cases)	14.3 %	(76 cases)
Adults	99.8 %	(3 671 cases)	85.7 %	(455 cases)

Table 2: Age groups – synoptic view

	BG reports (100 % = 3.679 reports)		Non-BG reports (100 % = 531 reports)	
Male	55.8 %	(2 056 cases)	51.8 %	(275 cases)
Female	30.7 %	(1 128 cases)	29.0 %	(154 cases)
Unknown	13.5 %	(495 cases)	19.2 %	(102 cases)

Table 3: Sex distribution – synoptic view

	BG reports (100 % = 3.679 reports)		Non-BG reports (100 % = 531 reports)	
None	3.4 %	(125 cases)	14.3 %	(76 cases)
Minor	87.7 %	(3 228 cases)	56.5 %	(300 cases)
Moderate	4.2 %	(153 cases)	9.0 %	(48 cases)
Severe	0.1 %	(4 cases)	4.9 %	(26 cases)
Cannot be assessed	4.6 %	(169 cases)	15.3 %	(81 cases)

Table 4: Degree of severity of health impairment – synoptic view

	Health impairment		
Product group	Minor (3 228 cases)	Moderate (153 cases)	Severe (4 cases)
Primary substances	718	50	4
Cleaning agents, total	792	45	
Drain cleaners	11	1	
All-purpose cleaners	48	4	
Oven and grill cleaners	22	2	
Descaling products	24	1	
Industrial cleaners	70	3	
Milking machine cleaners	63	7	
Metal cleaners	23	2	
Lavatory cleansers	39	1	
Disinfectants/sterilizers	350	9	
Medicinal products	193	2	
Paints and related materials	131	2	
Pesticides	107	2	
Waste gases	91	1	
Building materials	85	11	
Accumulators	49	2	

Table 5: Product groups involved most frequently, by degree of severity of health impairment (BG reports)

	Health impairment		
Product group	Minor (300 cases)	Moderate (48 cases)	Severe (26 cases)
Industrial accidents	89	2	2
Primary substances	82	4	4
Cleaning agents, total	27	9	7
Descaling products	3		
Dishwashing detergent	2		2
Drain cleaners			2
Lavatory cleansers	3		
Shoe and leather cleansers	4	2	1
Waste gases	18	9	1
Pesticides, total	10		2
Insecticides	8		2
Cosmetics	11		2
Primers	3	1	
Office materials, chemical	1		
Lamp oil			2
Foods and beverages	22	9	3
Alcoholic beverages	7	3	1
Fungi	2		
Medicinal products	12	4	2

Table 6: Product groups involved most frequently, by degree of severity of health impairment (non-BG reports)

ers. Cases of moderate and severe health impairment were mostly reported by medical practitioners or physicians working in hospitals (Table 4).

The product groups involved most frequently with regard to the degree of severity of health effects have been listed in Table 5 for the cases reported by the Berufsgenossenschaften, and in Table 6, for the cases reported by hospitals and medical practitioners. Of course, the toxicants reported from occupational environments were different from those reported to have been involved in the private sphere, on account of e.g. the differences in the availability of certain product groups.

2.2.6 Outcome of cases

Ten deaths were reported to the BfR in 2008:

A 24-year-old patient had ingested 4 g dinitrophenol, probably with a suicidal intent. In the course of his illness, he developed lactacidosis, rhabdomyolysis and malignant hyperthermia associated with cardiovascular insufficiency, among other manifestations, and died from their sequelae (see case report in Section 3.3.1).

Four cases were reported to the BfR by forensic institutes. The causes of these deaths have remained unclear. In one case, the patient had taken several food supplements. The causal relationship between the food supplements taken and the myocardial infarction suffered by the patient could not be assessed.

In another case reported by forensic institutes, an elderly female had accidentally ingested a dishwasher detergent which had been mistaken by her for a beverage. Aspiration of the detergent resulted in lung damage, and the patient died from the sequelae of these conditions (see case report in Section 3.3.6).

	BG reports (100 % = 3 679 reports)		Non-BG reports (100 % = 531 reports)	
Complete recovery	93.8 %	(3 451 cases)	77.0 %	(409 cases)
Late sequelae possible	0.2 %	(7 cases)	2.1 %	(11 cases)
Partial recovery	0.1 %	(2 cases)	0.8 %	(4 cases)
Death	0 %	(0 cases)	1.9 %	(10 cases)
Unknown	5.9 %	(219 cases)	18.2 %	(97 cases)

Table 7: Outcome of cases – synoptic view

A 28-year-old female died from the sequelae of hairspray abuse. In this case, the causal relationship could be confirmed.

Another case that could be confirmed by forensic medicine was the death of a 33-year-old male who had accidentally inhaled a relatively large amount of chloroethane from an aerosol can.

Another patient had ingested potassium cyanide with a suicidal intent. The BfR lacks information on the manifestations and course in this case.

Also with a suicidal intent, two patients had ingested pesticides containing phosphoric acid esters. Also in these cases, the only information available to the BfR is that both died from the sequelae of poisoning.

In another case, a female patient had taken a food supplement containing green-lipped mussel concentrate, among other ingredients, and had developed toxic hepatitis. The patient eventually died from the sequelae of liver parenchymal damage and multiple organ failure. The relationship between the toxicant and the manifestations observed was rated as possible (see case report in Section 3.3.7).

In the last fatal case reported, the relationship between the toxicant and the manifestations could not be assessed on the basis of the information available. The patient had ingested an unknown quantity of an energy drink as well as alcohol with abusive intent.

2.3 The product information system, PRINS

The reports by physicians in cases of poisoning legally required under the Chemicals Act (§ 16e para 2) are regularly evaluated to protect consumers from health risks posed by chemicals and chemical products in the sense of toxicological monitoring. Since 1994, the reporting physicians, the responsible ministries and the scientific community have been informed by annual reports on analyses of these reports and the corresponding results. In the context of these reports the term, poisoning, is used to designate any health impairment associated with chemicals, i.e. not only severe or life-threatening health disturbances but also undesirable health effects of products such as allergic symptoms and allergies.

Since 1998, manufacturers and distributors of chemical products such as household chemicals and DIY products, cosmetics, plant protection and pest control products and corresponding products for commercial use have been informed about selected and defined cases of health impairment associated with their products that have become known to the BfR through case reports. For this purpose, a formal product information system (PRINS) was established. In the event of reported health impairments, rapid communications are provided for in these cases, depending on the urgency of measures to be taken. By such approach, industry is enabled to immediately fulfil their obligations with regard to product

safety. All other reports are summarized and sent to the recipients at annual intervals.

2.3.1 Rapid communications

If reports on severe health risks are received by the BfR or a preparation is suspected of possibly involving a risk, the BfR will provide for immediate information of the manufacturer/distributor of the chemical product involved as well as the competent industrial association and the Federal Office of Consumer Protection and Food Safety. In addition, an immediate report is submitted to the three competent ministries, i.e. the Federal Ministry of Food, Agriculture and Consumer Protection (BMELV), the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), and the Federal Ministry of Health (BMG). Suicides, abuse and improper use are excluded from rapid communications.

Criteria for a rapid communication include

- severe manifestations,
- no suicide or abuse,
- no incorrect use.

Between 1 January 1998 and 31 December 2008, 28 rapid communications were prepared and communicated. A synoptic view of the last five years is given in Table 8.

In the reporting year of 2008, two rapid communications were distributed. The first one referred to an 80-year-old female patient suffering from dementia who had mistaken a manual dishwasher detergent for orange juice

Year	Product	Toxicologically relevant substance	Person exposed	Outcome	Proposal by the BfR (P) and results (R)
2004	Garden torch	Paraffins, colourless	Young child	Respiratory insufficiency, death	P: Information R: Accepted
2004	Oil lamp	Paraffins, colourless	Young child	Respiratory insufficiency, death	P: Information R: Accepted
2005	Detergents	Surfactant	Elderly male	Death	None
2005	Dishwasher cleanser for industrial use	Potassium hydroxide	Elderly female	Severe chemical burns	None
2005	Breadseed poppy	Morphine	Infant	Respiratory insufficiency	P: Guideline values/maximum levels, control, measures to reduce opiate levels R: Accepted
2006	Detergents	Surfactant	Elderly female	Death	None
2007	Impregnation spray for tents	Cannot be assessed	Adult female	Pulmonary oedema	P: Investigation
2008	Manual dishwashing detergent	Surfactants	Elderly female	Foam aspiration, death	P: Information
2008	Shoe impregnation spray	Cannot be assessed	Adult male	Pulmonary oedema	P: Investigation

Table 8: Rapid communications 1 January 2004 – 31 December 2008

due to its orange colour and the picture of oranges shown on the label. She was found dead on the next day. Post-mortem examination found remainders of dishwasher detergent in her lungs suggesting that aspiration had been the cause of death. This case has been described in detail in Section 3.3.6.

The second case referred to a poisoning accident in a 26-year-old patient who had developed toxic pulmonary oedema after the use and inhalation of a shoe impregnation spray. This case has been described in detail in Section 3.3.5.

For explanations of individual cases up to 2007, reference is made to the previous annual reports.

2.3.2 Summary reports

Information on reports referring to cases of non-severe health impairment caused by chemical products in occupational or private environments are transmitted to the responsible manufacturers/distributors in a summarized form in the year following the incidents. Since 2003, also suicides and attempted suicides have been included in the summary reports, irrespective of the degree of severity of poisoning. Rarely, also reports of severe cases are submitted to manufacturers in the form of a summary report if the data available were insufficient for a rapid communication.

Summary reports provide information in tabular form which, depending on the data available from the case reports, includes the following elements:

- Product name;
- Date of receipt by the BfR of the report on the case of poisoning;
- Case number;
- Anonymized patient data such as sex and age group;
- Aetiology of the poisoning case (e.g. accidental or common use, abuse or mistake);
- Site of exposure (workplace or private sphere);
- Duration of exposure (acute or chronic);
- Degree of severity of health impairment as assessed by the BfR.

Cases reported to the BfR will only result in a report being sent to the manufacturers if a causal relationship between the health impairment experienced and the product mentioned is considered at least as possible after evaluation by the BfR. Information is also submitted on cases reported for which the degree of severity and/or the causal relationship cannot be assessed. Also in these cases, it is intended to draw the manufacturer's attention to risks that may arise from his product.

By means of the BfR summary reports, manufacturers and distributors will gain knowledge on possible risks associated with the handling of their products. In single cases, they will not be satisfied by such summarized information and seek contact with the BfR in writing or by telephone in order to obtain more detailed information on a specific case of poisoning.

After evaluation of the total of 4 210 reports on cases of poisoning received by the BfR in 2008, 414 of these resulted in summary reports to the corresponding manufacturers according to the criteria mentioned above. These cases referred to 434 different products from 138 different manufacturers.

Table 9 provides a synoptic view of product application groups to which the summary reports on frequently listed products can be assigned. As in the previous years, the majority of reports referred to accidents involving chemical products (total 307), with cleaning products stated most frequently (169). Also the number of reports referring to disinfectants has remained high (90). As compared to the preceding years, the number of reports referring to milking machine cleaners had increased markedly (11, 20, and now 38).

First level	Number	Second level	Number	Third level	Number
Chemical products	307	Paints and related materials	11	Paint removers/ strippers	1
				Glossy paints	2
				Primers	6
				Paint thinners	1
		Building materials, auxiliary products	9		
		Building materials	2		
		Fuels, liquid	1	Lamp oil	1
		Dental materials	2		
		Disinfectants/ sterilizers	90		
		Antifreezes	1		
		Refrigerants	1		
		Glues	3		
		Coolants	1		
		Solvents for technical use	1		
		Metallurgy, auxiliary products	1		
		Cleaning products	169	Drain cleaners	1
				All-purpose cleaners	10
				Oven cleansers	1
				Descaling products	6
				Front wall and stone cleaners	1
				Washing-up detergents (manual use)	1
				Dishwasher detergent	3
				Dishwasher cleaners	1
				Industrial cleaners	19
				Milking machine cleaners	38
				Metal cleaners	2
				Lavatory cleansers	19
				Shoe and leather cleaners	6
				Detergents	1
		Lubricants	2		
		Water treatment products	1		

First level	Number	Second level	Number	Third level	Number
Cosmetics/personal hygiene products	11	Hair care products	1	Hair conditioners	1
		Skin care products	3	Creams/ointments	1
				Soaps	2
		Nail care products	6		
Pesticides	35	Fungicides	5		
		Herbicides	14		
		Wood preservatives	2		
		Insecticides	12	Phosphoric esters	3
				Pyrethroids	4
Agrochemicals	12	Fertilizers	1		
Primary substances	9				
Others	3	Textiles	1	Clothing	1
Industrial accidents	57				

Table 9: Product groups frequently involved (based on 2008 summary reports)

The 414 cases leading to summary reports to manufacturers referred to health impairments characterized by the following degrees of severity (see Table 10):

Degree of severity of health impairment	No. of cases
Minor	323
Moderate	28
Severe	4
Cannot be assessed	59

Table 10: Degrees of severity of cases in summary reports 2008

First level	Number	Second level	Number	Third level	Number
Chemical products	24	Paints and related materials	1	Primers	1
		Building materials	1		
		Disinfectants/ sterilizers	4		
		Coolants	1		
		Cleaning products	17	All-purpose cleaners	1
				Oven cleansers	1
				Industrial cleaners	2
				Metal cleaners	1
				Shoe and leather cleaners	2
				Milking machine cleaners	4
Cosmetics/personal hygiene products	2	Nail care products	2		
Pesticides	2	Fungicides	1		
		Insecticides	1		

First level	Number	Second level	Number	Third level	Number
Agrochemicals	1				
Primary substances	1				
Others	1				

Table 11: Product groups involved in cases of moderate health impairment as listed in summary reports for 2008

Table 11 shows the number of products in the individual product groups that were involved in moderate health impairments (31 products, multiple listing per case is possible). It may be concluded that an involvement in cases of moderate health impairment was seen for ca. 7 % of the total of 434 products listed in summary reports to manufacturers.

In 59 of the total number of 414 cases of poisoning where summary reports had to be sent to manufacturers, the degree of severity could not be assessed.

In four cases, no rapid communications were sent to the responsible persons in spite of severe health impairments reported because there was no need for action by the manufacturers involved. The manufacturers were informed about the accidents afterwards in summarized form. One case was that of attempted suicide of an elderly male who had ingested lamp oil. Another case referred to improper use of a dishwasher detergent, and in a third, a young female had died from hair spray abuse. A young child suffered severe chemical burns of the oesophagus because a drain cleaner had been filled into a common beverage bottle. While playing, the child had ingested a sip of the highly corrosive agent. The origin of the bottle could not be elucidated.

The BfR also performs cumulative data analyses of case reports. If trends become apparent, the manufacturers of the products concerned are informed. In turn, manufacturers are requested by the BfR to communicate comparable data and trends that may serve to improve product safety.

3 Selected toxicological problems

3.1 Major accidents

Major chemical accidents involving high numbers of persons may be caused by fires, industrial accidents involving chemicals, transportation accidents, natural disasters, but possibly also terrorist attacks, where under certain circumstances many people are injured or otherwise affected.

Phase	Activities	Time after accident
I	**Rescue** Fire brigades/police/emergency physicians/Poison Control Centres Acute medical care, damage limitation, ensuring of communication, warnings and/or alarms, if required	As early as possible
II	**First inventory/first measures** Organization of crisis committee, activation of networks, establishment of telephone trees, first information and warning of the population, recommendations for behaviour to reduce exposure, identification of injured/affected persons and extent of damage, advance notice to hospitals, if required, first systematic ascertainment of information, first orienting measurements of contaminant levels, evacuation of affected persons if required, risk groups, more detailed information of the population, physicians and the media, initiation of systematic risk communication	Within the first hour/hours
III	**Detailed recording of the situation/exposure monitoring** Exposure measurements in air and soil (ambient monitoring, external exposure), measurements of exposure in persons affected (human biomonitoring, internal exposure), risk communication by means of continued information of the population, physicians and the media	Start on the first day
IV a	**Measures to reduce exposure** Cleaning and rehabilitation measures	Start as early as possible, within the first days
IV b	**Standardized documentation of sequelae** • Precise identification of persons affected • Register of exposure • Examinations • Follow-up examinations	Start as early as possible, within the first days
V	**Detailed evaluation/long-term examinations, if required** Evaluation of data, evaluation of registers (physician's reports under § 16e ChemG, Poison Control Centres, human biomonitoring etc., toxicological-epidemiological expert opinions, intermediate-/long-term studies	Months, years
	Accompanying risk communication	

Table 12: Activities to be performed in the event of major accidents involving chemical substances or products

Following a major escape of chemical substances (chemicals, gases, aerosols, particles), it is important for the responsible persons, company doctors and competent authorities to get, as soon as possible, an overview of the situation, initiate rescue and protective measures and inform the population affected (see Table 12). As a rule, the decisions on the approach in cases of major industrial accidents are made by a crisis committee consisting of representatives of the fire brigades, police, emergency physicians, senior officials and public health service.

In addition to a rapidly available and proper medical care and the protection of the neighbouring population, immediate and responsible (risk) communication between the various institutions and responsible bodies involved has to take place. Information and communication errors leading to misinformation may result in panic reactions among the persons affected and the population. This risk is particularly high during large-scale and mass events (such as football matches or religious events, e.g. those taking place in India or during the pilgrimage to Mecca). However, also experiences with alleged cases of poisoning prematurely communicated by radio and TV stations have shown considerable risks producing far-reaching uncertainty among the population, as has been demonstrated by the following situations that have come to the knowledge of the BfR:

- A single male person had suffered severe pain from an injury on his thumb that had been caused by contact with fruit acid from an orange juice pack bought at a discount store. After an immediate announcement of the incident on the radio, countless people all over the Federal Republic of Germany presented to physicians or hospitals with supposed “chemical burns”. Subsequently, the entire production batch was recalled.
- An unqualified radio announcement made after a motorway accident involving a tanker transporting chemicals of low toxicity resulted in numerous rear-end collisions and alleged symptoms in drivers in the vicinity of the accident, up to a distance of about 50 km from the site of the accident.
- An alleged odour of bitter almond in a classroom led to a panic reaction and hasty evacuation of the school. Some of the students were admitted to hospital and treated for cardiac arrhythmia. According to the results of an inspection performed under conditions of professional protection against poisoning, the strange smell had been caused by a commercial air freshener in tree form, of 8 cm height with a fragrance called “forest freshness”.

3.1.1 Accidents in schools

School accidents involving chemicals are in most cases caused by reagents, apparatus or instruments used in physics or chemistry lessons. Particularly during chemistry lessons, students are supposed to become acquainted with the practical handling of or experimenting with chemicals.

As compared to the past, the handling of chemicals in chemistry lessons has become strictly

Fig. 7: Chemistry lesson

limited by legal regulations and is now subject to the same safety standards and conditions as in the chemical industry. Hence, accidents, even if occurring rarely, are in most cases to be attributed to a chain of unfortunate circumstances, possibly to carelessness of teachers violating their obligations or to misjudgement of a situation.

3.1.1.1 Panic reaction after occupational accident at school in male adult involving a broken mercury barometer

A 52-year-old employee of a cleaning company had been cleaning the physics classroom of a school on a Thursday evening. During this activity, he had accidentally knocked over a mercury barometer of ca. 1 m length. Due to its strong cohesion, the spilled mercury formed a great number of small droplets which spread over the room. The cleaning operator tried to sweep up these droplets using a dustpan and brush and discarded them in a garbage bag. In order to remove also the remainders he cleaned the classroom with a mop. Subsequently, he continued to use the latter when cleaning the other classrooms. On the next morning, before school started, a teacher discovered the broken barometer and called the fire brigade. The firemen of the professional fire brigade took up the remaining mercury droplets and properly discarded them together with the garbage bag in a special container. The cleaning operator was brought to the toxicological department of a hospital by the emergency rescue service for a thorough examination. None of the students came into contact with the mercury. For them, this incident meant a restriction in the number of physics lessons because the physics classroom had to remain closed until complete cleaning had been performed by a specialist company.

Manifestations/course
The patient did not experience any complaints. He only stated to have been suffering from shoulder pain for the last 14 days. The physical examination revealed hypertension of 184/111 mmHg as well as tachycardia of 88/min. 20 minutes later, the patient's blood pressure had decreased to 157/100 mmHg without medication as a result of staying in a quiet environment, while his heart rate was 119/min. Other physical findings were normal except for a strain in the right shoulder. All results for routinely measured laboratory parameters were within the normal ranges.

To exclude or confirm, respectively, a possible inhalational uptake of mercury, its urine concentration was determined. The analysis resulted in a value of 0.1 µg/l (reference range: 0 - 1.0 for persons without amalgam fillings) and thus, did not exceed the HBM I value. Likewise, there were no clinical signs of mercury poisoning. Inhalation poisoning from mercury could therefore be excluded. The patient was discharged in a symptom-free condition.

On the next day, i.e. on Friday, the incident was reported by a local newspaper. As a consequence since Monday morning, more and more alarmed parents were seeking medical attention for their children in order to have a mercury poisoning excluded. In addition, a crisis team of the school authority discussed when and by whom the school building should be cleaned.

Notes
On principle, a distinction has to be made between poisoning with elemental mercury and such with inorganic or organic mercury compounds. Elemental mercury mostly originates from broken thermometers. It is also contained in manometers and barometers, respectively,

mercury vapour lamps and special batteries. In addition, it is used in dental amalgams. Like its compounds, mercury originates from industrial emissions, from households and from crematoriums (tooth fillings). Mercury found in the environment is almost exclusively of anthropogenic origin.

Mercury will evaporate already at room temperature, albeit relatively slowly. At moderately high temperatures, it will evaporate rather quickly. Since it is readily absorbed by the inhalatory route (75 -100 %), poisoning caused by leaking thermometers may occur in small and poorly ventilated rooms. Also, a severe poisoning accident has been described when a thermometer had become broken on a hot cooktop and the mercury had evaporated quickly within a confined space. Absorption through the intact skin is possible owing to its very fine dispersion. It regularly takes place after application of mercury-based ointments. When absorbed through the gastrointestinal tract, mercury is relatively harmless. Ingestion of small amounts such as the quantity contained in a clinical thermometer will not result in any relevant absorption (<0.01 %). The daily mercury intake levels for persons who are not occupationally exposed are 5 µg in the USA, 10 µg in Sweden, and 8 – 27 µg in Germany. Exposure takes place predominantly through the consumption of fish and fish products. Tooth fillings containing amalgam lead to an additional absorption of 2.5 – 10 (-17.5) µg Hg/day. According to the German Environmental Survey, average mercury levels detected in the German population are 0.5 µg/l in blood, 0.25 µg/l in urine, or 0.34 µg/g creatinine. The tolerable maximum levels in terms of occupational medicine (BAT - Biologischer Arbeitsstoff-Toleranzwert) have been fixed at 50 µg/l in blood and 200 µg/l in urine. It has been discussed, however, whether these limits are too high and whether signs of micromercurialism may be developed by predisposed persons already at these levels.

The toxic effect of mercury is based on its ability to denature protein (local effect) and cause a blocking of active SH groups of enzymes. It will act predominantly as a chronic and accumulating poison, due to its slow excretion. The half-life of elemental mercury is 58 days. In children, chronic poisoning will result in Feer's disease (also referred to as acrodynia, pink disease, Swift-Feer disease, Selter's disease). Manifestations will include cerebral, vegetative and dermal symptoms such as pronounced muscular hypotension, later followed by refusal to walk, stand and sit, listlessness, grumpy and whiny behaviour, apathy of motor origin, muscle and limb pain, loss of appetite, weight loss, sleep disorders, profuse sweating, photophobia, pronounced itch, symmetrical reddening of the skin on nose, hands and feet, predominantly distal coarse scaling on hands and feet, increase of blood pressure and tachycardia. Obviously, a child's body is more sensitive to relatively low quantities of mercury. In individual cases, infants and young children are known to have developed severe manifestations of disease at urine concentrations markedly lower than 50 µg/l, particularly after inhalation of mercury vapours. Adults will develop similar manifestations, which may include hearing disturbance, tremor (typical shaky handwriting), persistent depressive mood, disturbance of memory, decrease in vitality and sleep disorder. Patients will become highly irritable and distrustful. This makes them difficult to deal with, and they may erroneously be diagnosed with a primarily psychiatric condition or vegetative syndrome As a result, a targeted and clarifying diagnostic work-up is omitted and no causal treatment is initiated. Acute inhalation of large amounts or high concentrations of mercury vapour will typically be followed by pulmonary complaints including cough, dyspnoea with signs of airway obstruction, interstitial pneumonia, necrotizing bronchiolitis, or acute pulmonary oedema. Subsequently, patients may develop lung fibrosis. CNS manifestations described include headache, dizziness, tremor,

ataxia, visual disturbances with restrictions of the visual field and mental changes.

Treatment will depend on the clinical manifestations, the patient's age and the mercury levels detected. After inhalation of elemental mercury vapour, persons exposed should be removed from the danger area. Subsequently, oxygen should be given and topical glucocorticoids administered by inhalation. In cases showing signs of airway obstruction, administration of beta-2 sympathomimetics by inhalation is recommended, and severe cough should be treated by administration of antitussive agents. The treatment of toxic pulmonary oedema should include i.v. administration of glucocorticoids, intubation and artificial respiration. An antidote is available, namely DMPS (dimercaptopropane sulfonate), a chelating agent. It is mainly administered in cases of severe acute poisoning, by e.g. mercury salts. In rare cases of chronic poisoning, however, DMPS has to be administered over an extended period of time. No established regimens exist for treatment of such cases so that the therapeutic plan should be developed in cooperation with experienced toxicologists or Poison Control Centres.

In the case described above, the presence of a relevant mercury poisoning had not to be assumed because of the short period of inhalatory exposure at relatively low temperatures (room temperature). For forensic reasons (occupational accident), however, poisoning had to be excluded on the basis of a medical examination and findings of (normal) urine levels. Due to the panic associated with the accident situation, the patient showed an elevated blood pressure. In addition, attention is drawn to the risk of acrodynia in the sense of Feer's disease: It could be assumed that the students had not been at risk with regard to poisoning because no exposure had taken place. A proper disposal of the mercury that had leaked from the barometer was carried out by a specialist company.

Evaluation of the case described
Based on the history, the absence of manifestations, the normal medical findings and a non-elevated mercury level in the urine, mercury poisoning could be excluded.

3.1.1.2 Accident during chemistry lesson involving nitric acid

In a school accident, a number of students and teachers suffered injuries when a bottle containing nitric acid broke. For precautionary reasons, the entire school was evacuated and cleaned by fire department specialists. According to media reports, a bottle containing 1.5 L of nitric acid had fallen down and broken on the floor during a chemistry lesson in the morning. 13 students and a teacher were brought to the University Hospital for precautionary reasons. Another twelve students and another teacher were brought to another hospital because of suspected allergic reactions. For 23 of the patients treated, medical reports in the form of case reports according to § 16e Chemicals Act were received by the BfR.

Manifestations/course
About one half of the students had no health complaints on admission to hospital. They were discharged on the same day, however, after having been administered steroids by inhalation for prophylactic reasons. All students who on admission to hospital had exhibited any manifestations, i.e. including mild ones, were admitted as inpatients and also administered steroids by inhalation. In cases of minor health impairment, the students complained of nausea and moderate breathing difficulty after the inhalation of nitric acid vapours. In cases of dermal contact, however, findings also included erythema and blistering. Three of the students complained of eye burning and excess tear secretion. Two of the students were affected more

severely. They had been hit by splashes of acid and suffered chemical burns in the sense of multiple small foci of dermal necrosis. In one case, a splash had directly hit the patient's eye. The BfR did not receive information about the further course.

Notes

Nitric acid is one of the strongest mineral acids. In diluted solutions, it is almost completely dissociated. It is a strong oxidant capable of dissolving almost all metals except gold and platinum and producing brown nitrogen oxides. In a 50 % solution, nitric acid is used as "aqua fortis" for separating gold and silver. A mixture of nitric and hydrochloric acid, referred to as "aqua regia", can also dissolve gold. In its pure state, nitric acid is colourless. Concentrated nitric acid, however, decomposes readily (especially when exposed to light) and often has a yellowish or reddish colour shade due to the nitrogen dioxide (NO_2) dissolved in it. Pure nitric acid, which contains free nitrogen dioxide, is referred to as fuming nitric acid and has an unpleasant pungent odour. Nitric acid is one of the most important inorganic basic chemicals. Nitric acid is used e.g. for the production of fertilizers and explosives. It is also used for the production of glossy paints and synthetic leather. In the production process of other acids, it serves as an oxidant or as a reagent for analysis.

Similar to hydrochloric and sulfuric acids, nitric acid has a strong corrosive effect. Depending on the concentration and duration of exposure, skin reactions may vary from mild irritation to severe third-degree chemical burns. Particularly severe courses have often been seen in cases of gastrointestinal chemical burns after ingestion of nitric acid in cases of attempted suicide. A conspicuous sign, even if of no pathological significance, is provided by a typical yellow discoloration of the skin that can be regarded as evidence of exposure to nitric acid. Such yellow discoloration is caused by the xanthoprotein reaction. In organic chemistry, this reaction is used for the identification of aromatic amino acids. Addition of nitric acid will be followed by nitration on the benzene ring of these amino acids resulting in the formation of a yellow nitro compound. For the same reason, skin exposed to concentrated nitric acid will take on a yellowish colour because the epidermal cells contain aromatic protein molecules. The necrotic-inflammatory tissue damage indicates a process of protein denaturation.

Contact of nitric acid with metals or organic material results in the formation of nitrous gases (NOx). If such gases have a high share of nitrogen monoxide (NO), inhalation by humans may result in methaemoglobinaemia. Due to their lipophilic properties, higher nitrogen oxides may cause toxic pulmonary reactions ending with pulmonary oedema.

In addition to the corrosive effect, poisoning with nitrous gases by inhalation therefore poses the risk of pulmonary oedema that may develop with a delay of up to 24 hours after exposure. In rare cases, patients may develop bronchiolitis obliterans and alveolitis several weeks later, after mild initial manifestations, which may even take a fatal course. Late sequelae that have been described include lung fibrosis. The German MAK level (maximale Arbeitsplatzkonzentration – maximum admissible concentration at the workplace) has been set at 2 mL/m³ (ppm)/5 mg/m³.

Treatment after dermal contact is performed as usual in cases of burns. Residual acid should be dabbed away with absorbent material and contaminated clothes removed. Subsequently, the skin should be rinsed with large amounts of water.

After ingestion of nitric acid, water should only be administered as a first aid measure in order to "rinse" the oesophagus. It is imperative to

take care that the stomach is not overfilled. In cases of clearly identified chemical burns of the gastrointestinal tract, the following principles apply: Vomiting should not be induced, no charcoal administered, and no neutralization performed. Gastric lavage is not indicated since it is not intended to remove substances that may be absorbed, and there is a risk of perforation.

Immediate endoscopic examination and gastric evacuation after ingestion are to be considered in exceptional cases only, for example after suicidal ingestion of considerable amounts of acids. In addition to severe local damage, also the systemic effect resulting from absorption of the acid has to be taken into account in such cases. Because of the risk of perforation, this examination should be carried out by experienced medical staff only.

After inhalation exposure to nitric acid, early administration of topical steroids is required to prevent pulmonary oedema. In all cases, immediate admission to hospital and monitoring of the patient affected is required.

Evaluation of the case described
Based on the information given about the temporal relationship between the exposure to nitric acid and the appearance of manifestations, a causal relationship is considered as probable in the cases described.

3.1.2 Chemical accidents
Chemical accidents may occur in the chemical industry proper, during the transport of chemicals (transport of dangerous chemicals by rail, ship or lorry), during storage (e.g. at wholesalers' premises) or in laboratories (industry, free trades or at scientific institutions, universities etc.).

3.1.2.1 Severe case of poisoning due to phosgene inhalation during chemical accident

On 14 March 08, a chemical accident occurred in the town of Garching (near Munich), which had been caused by a technical defect. At about 6:00 p.m., in a laboratory of the Technical University Munich, a tube detached itself from an experimental setup in which phosgene was being generated from triphosgene and transferred to a synthesis flask so that phosgene could escape. The apparatus was located in a laboratory with reinforced exhaust ventilation, a so-called "stink room". A 61-year-old professor of chemistry terminated the generation and escape of phosgene by cooling down the phosgene-releasing reaction mixture and reconnecting the ground glass joint. During these operations, he was exposed to phosgene for no longer than 5 minutes. He stated that he had not perceived the smell or taste neither of phosgene nor of hydrochloric acid during that period and that in the past, he had been exposed to phosgene quite frequently without having experienced any serious health complaints. The only symptom experienced by him on the occasion of an earlier instance of inhalation of higher and more dangerous phosgene concentrations had been a retching sensation in the throat, so that he discontinued the operation leading to exposure. He stated not to have experienced such sensations this time.

At about 11 p.m., the patient presented to a hospital for outpatient medical consultation although he had not experienced any complaints up to that time. At the hospital, he was also found to be asymptomatic and discharged to his home. On the next morning, he woke up at about 6 a.m. with obvious pulmonary manifestations. He noted a bubbling sound in his lungs and exertional dyspnoea when climbing stairs. 18 hours after the acci-

dent had happened he was brought to a hospital by the emergency rescue service and admitted to the toxicological department. The patient had no history of pulmonary or heart disease, and was a non-smoker.

Altogether, 40 persons had been affected by this chemical accident, two of these suffered severe health disorders. Both developed toxic pulmonary oedema. One of them was the patient described in this case report, the other person affected was a female student who had been directly involved in the experiment.

Manifestations/course
On admission, the patient was capable of orientation, and his neurological findings were normal. Findings included tachycardia of 122/minute, a clearly audible and bubbling respiration over all pulmonary segments, and cyanosis. Oxygen saturation measured by means of pulse oximetry was below 70 %. Therefore, the patient was administered 12 liters of oxygen/minute by means of a mask. As a result, oxygen saturation increased to 88 %. Radiological findings revealed marked pulmonary oedema with a small effusion in the costophrenic angle. Clinical chemistry revealed a quick increase in CRP as well as leukocytosis of 14 270/µL, which became even more pronounced under steroid therapy. Because of the delayed-type pulmonary oedema typical of phosgene inhalation, the patient was administered 500 mg prednisolone i. v. on the first day and 1000 mg on each of the two following days as well as diuretics with simultaneous monitoring of potassium levels and adequate substitution.

In the further course, auscultatory findings and subjective well-being of the patient improved continuously. Radiological findings showed a regression of pulmonary oedema, and CRP levels were found to decrease. Five days after the incident, the patient was almost symptom-free. Lung function testing revealed mild obstruction/restriction as well as a slight reduction of diffusion capacity. Blood gas analysis still revealed hypoxia which, however, improved under conditions of exercise, climbing of stairs was possible without complaints. After a total of six days, the patient could be discharged with the recommendation to immediately seek medical assistance in the event of renewed complaints. An outpatient follow-up appointment for lung function testing was arranged for a week later.

Notes
Phosgene is the common name for carbon oxychloride or carbonyl chloride, $COCl_2$, the dichloride of carbonic acid. It was synthesized for the first time in 1812 by Sir Humphrey Davy. The Greek name, phosgene, goes back to the photoinduced addition of chlorine gas to carbon monoxide carried out by him and means "produced by means of light".

During World War I, phosgene was used as a chemical warfare agent under the German name of "Grünkreuz" (Green Cross). Phosgene has a characteristic odour that has been described as sweetish-musty and is easy to identify. Due to the hazard posed by this substance it is nowadays produced in the chemical industry preferentially within the plant where it is used, in order to avoid transport.

Phosgene is a very toxic gas and its intake is by the inhalational route only. When inhaled, the substance may penetrate into the alveoli where, under the prevailing humid conditions, it will gradually decompose to form carbon dioxide and hydrochloric acid. The latter will predominantly damage the alveoli and bronchioles resulting in disturbances of permeability. Due to its poor water solubility and high lipid solubility, phosgene is rated among the "latency type" irritant gases. Initially mild symptoms will be

followed by agonizing cough and cyanosis after a latency period of two to three hours. After a deceitful improvement, the clinical picture of fully developed toxic lung oedema may develop over the next 12 – 24 hours. If such poisoning remains untreated, it will in most cases have a lethal outcome. In single cases, alveolitis or bronchiolitis obliterans may develop even weeks later. Lung fibrosis has been described as a possible late sequel.

Exposed persons should quickly leave the gas-contaminated area. Other measures to be performed include immobilization and if required, sedation and protection against a loss of body heat. For persons affected, intensive medical monitoring is recommended. In spite of mild initial manifestations, glucocorticoids should be consistently administered by inhalation (CFC-free metered dose inhaler, e.g. budenoside) as soon as possible in order to prevent imminent pulmonary oedema. If a massive exposure is assumed to have taken place, i.v. injection of high doses of glucocorticoids (preferably methylprednisolone) is indicated. Onward therapy of pulmonary oedema will be oriented by the symptoms. With regard to possible late sequelae, follow-up observation including control of lung function, chest X-ray and medical supervision by a specialist is recommended.

In the case described, the lack of initial symptoms suggested a mild course. The patient was discharged without being administered any treatment to prevent pulmonary oedema and without being monitored. As a characteristic feature of phosgene poisoning, manifestations occurred only after a 12-hour latency period. This is why toxic lung oedema could no longer be prevented. However, treatment by means of appropriate therapeutic measures was successful.

Evaluation of the case described
Based on the temporal relationship between the exposure and the appearance of symptoms, a severe phosgene poisoning has been rated as probable.

3.1.2.2 Occupational accident with fatal outcome due to formation of chlorine gas

During a chemical accident on the premises of a plant, a 40-year-old worker suffered a toxic pulmonary oedema when transferring hydrochloric acid from a tanker. Accidentally, a wrong pipe connection was used and hydrochloric acid transferred to a tank containing bleach (sodium hypochlorite). This resulted in a strong chemical reaction and the formation of a chlorine gas cloud spreading over a wide area. According to media reports, altogether 70 persons were injured and treated by emergency physicians and paramedics at the scene of the accident. 27 of the patients were admitted to nearby hospitals. Most of the persons affected complained of eye burning, cough and moderate breathing difficulties and could be discharged after a short period of observation. Two of the persons affected developed signs of incipient pulmonary oedema. Nevertheless, after three days of inpatient treatment, they could be discharged in a symptom-free condition. The 40-year-old worker was most affected because he had been standing close to the tanker and had been most intensively exposed to the chlorine gas cloud. In spite of medical emergency measures initiated still on the scene of the accident and initial stabilization, the patient died five weeks later from the sequelae of massive chlorine gas poisoning, after having developed lung failure and subsequent multiple organ failure.

Manifestations/course
An emergency physician was called immediately after the accident. When he arrived, the 40-year-old worker had already become extremely dyspnoeic and unconscious so that he had to be intubated and respirated. He

was administered 1000 mg prednisolone i.v. On admission to a nearby hospital, the patient was in a reduced general condition, however, his circulation was initially stable. At that time, findings included pronounced pulmonary oedema that was clinically and radiologically confirmed and required continuous artificial respiration and sedation. Repeatedly, the tube was blocked and gas supply impeded by formation of massive bloody secretion. These problems were overcome. However, in spite of lung-protective inverse-ratio ventilation with 100 % oxygen and high ventilation pressures (last PEEP: 18 mm Hg), no sufficient oxygenation was achieved. Due to the continuous deterioration of the patient's respiratory situation and because catecholamine had to be administered during respiration after the patient had suffered a circulatory shock, he was referred to the intensive care unit of a specialized hospital by rescue helicopter.

The blood gas values measured on referral were: pa O_2 80 mmHg, pCO_2 42.6 %, pH 7.23, and SpO_2 91 %. After bronchoscopy and aspiration of 500 ml oedematous fluid, an improvement of gas exchange could be achieved for a short period only. The patient still required artificial respiration. The required sedation was difficult to achieve. On the fourth day after referral, dilatation tracheotomy was performed due to the presence of massive bronchial spasm. However, despite hyperbaric ventilation, an uncontrollable continuous increase in carbon dioxide levels up to 100 mm Hg was observed so that it was decided to perform artificial oxygenation of the blood by means of a machine, the so-called pumpless extracorporeal interventional lung assist (ILA). This therapy resulted in satisfactory oxygen saturation, and five days later, the sedation of the patient could be reduced to such a degree that the continuous positive airway pressure (CPAP) mode could intermittently be switched to assisted spontaneous breathing (ASB) mode (CPAP/ASB mode). However, a permanent complete CPAP respiration could not be achieved, in spite of an improved state of consciousness and good cooperation of the patient, because the gas exchange immediately deteriorated without machine support. The patient had developed a fibrotic transformation of the lungs. Repeated CT follow-up examinations again and again revealed the additional presence of constant infiltrates, in spite of continued antibiotic therapy. Pathogenic organisms could not be detected in any of the microbiological samples. In the course of the entire treatment period, the patient had developed increasing multiple organ failure affecting, in addition to his lungs, also his kidneys, circulatory system and gastrointestinal tract. In the last days of his life, his unstable circulatory situation predominated. Five weeks after the occupational accident involving massive chlorine gas poisoning, the patient died with a clinical picture of cardiovascular failure that could no longer be controlled, associated with a septic shock.

On post-mortem, the findings of multiple organ failure were confirmed. The main findings included a change in lung tissue with consolidation and only a low residual air content as can be found after long-term respiration. According to the macroscopic post-mortem findings, lung failure was seen as the cause of death. The lung changes found might be explained as resulting from long-term respiration. It could not be elucidated retrospectively whether the chlorine gas poisoning had directly caused the lung changes described in the post-mortem findings. According to the post-mortem records, the inhalation of chlorine gas was considered at least as an indirect cause of death because it had resulted in the necessity of artificial respiration.

Notes
The chemical accident had been caused by accidental introduction of hydrochloric acid into a solution containing sodium hypochlorite, which in turn resulted in the release of chlorine gas from a chemical reaction.

Chlorine gas is of yellow-green colour, pungent smell, and strongly corrosive activity. It is formed e.g. during water treatment for the disinfection of swimming bath water and during treatment of water for human consumption. It may also be released in the household as a result of simultaneous use of bleaches containing sodium hypochlorite and a strong acid, as contained e.g. in lavatory cleansers. Chlorine gas is heavier than air and soluble in water. The main route of exposure is through the respiratory tract with an absorption rate of almost 100%. On inhalation, the gas will react with the moisture of the mucous membranes, forming hypochlorous acid and hydrochloric acid. Depending on the concentration and duration of exposure, this will immediately result in damage to the mucous membranes in the upper respiratory tract and in the eyes. In cases of minor health impairment, manifestations may include a sore and burning sensation in the throat, eye irritation and agonizing cough. More serious manifestations include dyspnoea, stridor or retrosternal pain. Vomiting is often observed. In cases of extended duration of exposure, also paleness and cyanosis will be observed. As in cases of exposure to irritant gases of moderate water solubility, pulmonary oedema may develop even after a latency period of 3 to 24 hours.

A glottic spasm and a swelling of the mucous membranes in the respiratory tract (glottic oedema, laryngeal oedema) are considered as the primary cause of acute dyspnoea found after exposure to very high concentrations. Extended duration of exposure will result in bloody cough and dyspnoea as well as signs of suffocation. After having overcome the acute manifestations, impairment of the lung function may still last for several months.

A concentration of 690 ppm (2 g/m^3) chlorine in the respiratory air has a lethal effect by causing respiratory arrest, a concentration of 50 ppm (150 mg/m^3) will also lead to death after _ to 1 hour of inhalation exposure. The olfactory threshold is 0.02-1 ppm, with a concentration in the air of 1 ppm (3 mg/m^3) already leading to nuisance due to irritation of the mucous membranes of the eyes, the nose and the throat. The German MAK (maximum admissible concentration at the workplace) is 0.5 ppm (1.5 mg/m^3).

As in any other case of exposure to irritant gases, the patient should be immediately removed from the gas-contaminated area, while observing precautions for self-protection of the helper. In addition to oxygen supply, important measures include physical immobilization and, if required, sedation and protection against a loss of body heat. Because of the risk of glottic and pulmonary oedema, a glucocorticoid should be administered by inhalation as early as possible also in cases exhibiting only mild symptoms. Even if a massive exposure to chlorine gas is only assumed to have taken place, i.v. injection of high doses of glucocorticoids is indicated.

Patients should be monitored at an intensive care unit. Onward therapy will be oriented by the symptoms. In cases developing pulmonary oedema, the most important measures include early positive end-expiratory pressure respiration as well as an exact assessment of fluid supply. After relevant initial manifestations, follow-up examinations of the lung function for several months are recommended with regard to possible late sequelae, also in cases taking a mild course.

Evaluation of the case described
Based on the information given on the temporal relationship between the exposure to chlorine gas and the appearance of severe manifestations, a causal relationship is considered as probable in the case described, and the case has been rated as one of severe chlorine gas

poisoning. It could not be elucidated by the post-mortem examination whether the chlorine gas poisoning with its sequelae has to be considered as the cause of death. The lung tissue changes described could also be attributed to the long-term respiration which was required in this case. However, since chlorine gas inhalation had resulted in the necessity of artificial respiration, the occupational accident involving exposure to chlorine gas has to be regarded at least as the indirect cause of the death of the 40-year-old worker.

3.1.2.3 Chemical accident involving dicyclopentadiene in North Rhine-Westphalia

In August 2008, an uncontrolled escape of dicyclopentadiene (a gaseous intermediate product) occurred in an industrial plant. During the production of the substance, a pressure relief valve had broken. A major quantity of the product that had escaped could be recovered in a collecting tank. However, due to the existing high pressure, the gaseous product formed a cloud so that the emitted gas could spread beyond the premises of the plant. Reaction with rainwater resulted in an extensive oleaginous contamination of the environment. Roads had to be closed off at short notice. About 150 firemen from three towns and in addition, up to 40 police officers had to be deployed. Altogether, about 300 litres of the substance escaped during the industrial accident. Persons who had become exposed experienced irritation of the airways, the eyes and the skin. According to press reports, altogether 54 persons exhibited manifestations. Part of the persons affected had to be treated in hospitals.

Manifestations and course
According to the information given by the emergency centre and the leading emergency physician, altogether 14 adults received outpatient treatment. Only one patient was admitted to hospital for reasons unrelated to the exposure. In most cases, the symptoms stated consisted in mild irritations of the airways and conjunctival irritation of the eyes.

Fig. 8: Chemical accident

Notes
Dicyclopentadiene is mainly absorbed through the respiratory tract. Absorption of the vapours through the respiratory tract has been demonstrated by inhalation studies in animals. Absorption through the skin is low. With regard to occupational handling, the substance is primarily considered as a local irritant. The undiluted substance or concentrated solution has shown irritant activity in the in rabbit eye tests. In rabbits, open or occlusive dermal application of dicyclopentadiene mostly resulted in moderate irritant effects. No skin-sensitizing potential was detected in two test runs in guinea pigs.

The vapours have an unpleasant camphor-like odour and act as an irritant to the mucous membranes of the eyes and airways even at low concentrations. Both eye irritancy and unpleasant odour are perceived as a clear warning signal so that exposure to higher concentrations will certainly be avoided by those involved.

Evaluation of the case described
Based on the temporal relationship between the exposure and the appearance of symptoms in

the persons exposed, the causal relationship between exposure to dicyclopentadiene and the health impairments experienced has been rated as probable.

3.1.2.4 Major accident involving carbon dioxide leaking from a defective fire-extinguishing installation

In a severe gas accident, more than 100 persons suffered injuries when after a fire in a paint factory, there was an uncontrolled leakage of carbon dioxide (CO_2) from the fire-extinguishing installation escaping to the outside and into the environment. It took some hours until the leakage could be closed.

The majority of the persons injured were company staff and firemen deployed on the scene of the accident. Also residents and other persons who had accidentally been staying in the vicinity suffered carbon dioxide poisoning. Firemen who entered the building wore protective masks for precautionary reasons. On the scene of the accident, the carbon dioxide concentration had soon reached critical values so that car engines just stopped because of oxygen deficiency. People became unconscious, among them three firemen who had been staying in front of the building without wearing respiratory protection gear. An elderly male who passed on his motor scooter also became unconscious and fell off his vehicle.

Owing to the fast and careful action of the deployed policemen and fire-fighters, a far more serious extent of the accident could be prevented. The helpers started immediately to warn people, to evacuate houses in the direct vicinity and to close off streets within a radius of 2 kilometres. Later even a helicopter was used to disperse the gas cloud. As late as nine hours after the gas had started to leak, the all clear could be given.

Already at an early stage, emergency physicians and paramedics as well as almost five hundred helpers were deployed. Within a very short time, medical tents were set up where first aid was given and blood gas analysis performed. Most of the persons affected complained of breathing difficulties and nausea. 19 patients had to be hospitalized.

Medical reports on eight cases from the number of persons affected were received by the BfR. Almost all of them had suffered minor health disorders and could be discharged from hospital after outpatient or short-term inpatient treatment in a symptom-free condition. A female was affected more severely. She was admitted to hospital with obvious signs of incipient pulmonary oedema. After one week, also she could be discharged in a well improved state of health and referred to her family doctor for further treatment.

Manifestations and course

Patient No. 1
A 72-year-old male was admitted to hospital because of breathing difficulty associated with the gas leakage. In addition, he complained of headache and nausea. Blood gas analysis revealed a low-grade partial respiratory insufficiency. X-ray and ECG findings were normal. After symptomatic therapy, the patient could be discharged on the next day, in a well improved condition.

Patient No. 2
A 55-year-old male who had become occupationally exposed to the fire-extinguisher gas during the accident was admitted to hospital with a hypertensive crisis. Laboratory analysis and blood gas analysis resulted in normal findings. After administration of nitro spray, the blood pressure values returned to normal

and the patient could be discharged on the same day.

Patient No. 3
The 51-year-old patient complained of vertigo and headache. Blood gas analysis did not reveal any pathological findings. The patient who did not require any special therapy could be discharged after a short period of observation. The BfR was not informed of the type of exposure (private or occupational) in this and in the next case described.

Patient No. 4
The 32-year-old male was admitted to hospital for acute dyspnoea and thoracic pain. He had become symptom-free already on admission and could be discharged without therapy after a short period of observation.

Patient No. 5
A 35-year-old male who had happened to stay in the vicinity of the gas leakage site was unconscious for a short period. On admission to hospital he had regained consciousness, but was still suffering from severe headache. Blood gas analysis and chest X-ray findings were normal. The laboratory parameters showed normal values except for a slight increase in creatine kinase levels. The patient was admitted to the hospital for one day of observation after which he could be discharged in a symptom-free condition.

Patient No. 6
After a short episode of unconsciousness, a 27-year-old male was admitted to hospital for observation. On admission, he was somnolent but responsive when addressed, and he still complained of persistent headache and vertigo. Blood gas analysis did not reveal any pathological findings. Symptomatic therapy with oxygen supply and inhalatory administration of steroids resulted in an improvement of such complaints so that the patient could be discharged on the next day in a stable general condition. The BfR was not informed whether the patient had become exposed at his workplace or had just by chance been staying on the scene of the accident.

Patient No. 7
The driver of a fire engine was admitted to hospital because of short-term unconsciousness followed by persistent dyspnoea, headache and vertigo. The patient had already been administered oxygen as a first-aid measure. On admission, he was awake, capable of orientation and responsive. Blood gas analysis and chest X-ray findings were normal. In the course of continued observation, the patient remained symptom-free so that he could be discharged in a stable general condition on the next day. The laboratory parameters only revealed a slight increase in creatine kinase levels which was attributed to the physical strain the patient had experienced during the deployment.

Patient No. 8
A 41-year-old female was admitted to hospital for diagnostic work-up after CO_2 poisoning with initial unconsciousness, a hypotonic circulatory situation and incipient pulmonary oedema. The BfR was not informed whether she was a staff member or had been staying near the accident site as a passer-by at the time of the gas leakage. According to the medical report, the patient had become intoxicated by inhalation of highly concentrated CO_2 in the respiratory air. On admission, the patient was still unconscious, but became awake after a short period. Lung auscultation revealed ubiquitous moist rales. The patient had a history of multiple sclerosis.

After i.v. and in the further course, inhalational administration of steroids, the initial

complaints improved very soon. However, since the patient still complained of marked thoracic pain occurring independently of movement and breathing, and her troponin I level was significantly elevated, a tentative diagnosis of concomitant myocarditis and perimyocarditis was made. As a result of therapy with non-steroidal antirheumatic agents and reduced physical activity, also these manifestations disappeared. The tentative diagnosis of myocarditis was supported, in addition to the troponin I level, by pathological ECG findings made two days later, showing intermittent terminal negative T waves in the chest leads V1 - V3. Echocardiography revealed a minor epi- and pericardial separation of the posterior myocardial wall without any indication of relevant pericardial effusion, as well as a concentric left ventricular hypertrophy in the presence of normal left ventricular function. Other findings included minimal mitral, tricuspid and pulmonary valve reflux, as well as slight pulmonary hypertension.

Initially, haemoptysis had been observed. The BfR did not receive any chest X-ray findings made on the day of admission. Computed tomography performed two days later revealed only residual infiltrates in the left upper lung lobe that were rated as an indication of previous bronchopneumonia. Prior to discharge, bronchoscopy and bronchoalveolar lavage were performed. Macroscopic examination did not reveal any pathological findings. Other examination results (cytology, bacteriology) were not made available to the BfR.

After one week of inpatient treatment, the patient could be discharged in an improved condition and referred to her family doctor's care.

Follow-up examinations at short intervals, especially of the patient's heart function, were recommended.

Evaluation of the cases described

In the last of the cases described, the degree of severity of the health disturbance was rated as moderate, in cases 1 to 7, as minor. Given the prompt appearance of manifestations after exposure to CO_2, the causal relationship has been rated as probable in all cases.

Notes

Carbon dioxide is produced by complete combustion of organic substances under conditions of a sufficient oxygen supply, such as during fires or explosions (where it is a component of flue gas), or during fermentation processes. It is a colourless and odourless gas readily dissolving in water. It is of comparatively poor reactivity and non-combustible. CO_2 is obtained from natural sources or by secondary purification of raw carbon dioxide from different chemical processes used in petroleum and natural gas refining.

Of the variety of uses of carbon dioxide that in the beverage and food industries is commonly the best known one. For the carbonation of soft drinks, CO_2 is added under high pressure, or natural "carbonated" mineral water is used.

Carbon dioxide is also used as a fertilizer in greenhouses. The reason for such CO_2 deficiency consists in photosynthetic consumption and insufficient supply of fresh air. For this purpose, carbon dioxide is introduced either directly in the form of pure gas or as a combustion product of propane or natural gas.

Having a concentration of ca. 0.04 per cent by volume, CO_2 is a natural component of air. When using carbon dioxide, it has to be taken into account that it can rarefy and/or displace the atmospheric oxygen necessary for breathing because carbon dioxide is about 1.5 times denser and thus heavier than air. This is why uncontrolled gas leakage may lead to dangerous concentrations at ground level, above all in cavities and basement rooms.

Because of its oxygen displacing characteristics, carbon dioxide is also used to extinguish fires, above all in hand-operated fire extinguishers and also in automatic fire-extinguishing installations. In stationary fire-extinguishing installations, carbon dioxide liquefied under pressure is stored in high-pressure steel cylinders or, cooled at -20 °C, in large low-pressure containers. If, depending on the type of the fire warning device involved, smoke, an extreme rise in temperature or flames are detected, the fire alarm centre will start the extinguishing process and the protected room is flooded with CO_2 displacing the oxygen from the source of the fire.

Carbon dioxide does not produce any warning effect. In biological terms, it is a largely inert gas, which is harmless in low concentrations, but has a narcotizing effect with increasing concentration and duration of exposure. The admissible limit value for CO_2 at the workplace is 0.5 per cent by volume for an eight-hour exposure per day. CO_2 concentrations of about 5 % in the inhaled air and the correspondingly reduced oxygen share will result in mild symptoms such as headache, tinnitus, vertigo and drowsiness. CO_2 concentrations of ca. 8-10 % and above will cause tachycardia, increase in blood pressure, dyspnoea and unconsciousness, i.e. a condition also referred to as CO_2 narcosis. Higher CO_2 concentrations may lead to central respiratory arrest already after a short period of exposure. In cases of exposure to concentrations of 8-20 %, a fatal outcome has to be expected within 30 to 60 minutes.

If carbon dioxide accumulation is suspected, lay persons should refrain from rescue attempts because of the risk for their own life involved. The rescue of an unconscious person from environments suspected of being CO_2 contaminated should be performed by professional firemen who are equipped with respirators. In a number of cases, entire families fell victim to poisoning from fermentation gas because several persons had inhaled carbon dioxide and became unconscious during the rescue of a family member.

In such a situation, professional help should be sought immediately. If possible, it is meaningful to provide effective ventilation. As the most urgent first-aid measure, exposed persons should be removed from the CO_2-contaminated environment as quickly as possible and supplied with oxygen, while observing precautions for self-protection of the helper(s).

The solubility of carbon dioxide in water depends on the existing temperature and pressure. With increasing pressure, a higher share of carbon dioxide can be dissolved in water. In rare cases, natural disasters involving carbon dioxide occurred obviously as a result of this physical property. The best known natural disaster of this type happened in 1986 at Lake Nyos in Cameroon, when more than 1 700 residents and thousand of animals lost their lives. On 21 August 1986, about 1.6 million tons of CO_2 were abruptly released from Lake Nyos and distributed in the environment as a gigantic "gas flow".

Lake Nyos is one of three lakes in the world known to be saturated with carbon dioxide. A magma pocket located underneath the area is the source of carbon dioxide, which rises to the surface from the lake's bottom. It is estimated that annually about 90 000 tons of CO_2 become dissolved in the water of the lake. The water in Lake Nyos is thermally stratified: Layers of warm water near the surface float on cold and denser layers closer to the lake's bottom. Sudden changes of the solubility conditions may lead to an abrupt CO_2 supersaturation and outgassing of large amounts of CO_2 from the water. The disaster was probably triggered by events such as a landslide, a small earthquake or volcanic activity leading to a rapid mixing of water layers. In this process, due to reduced pressure and temperature change, large quantities of water became supersaturated with CO_2

all of a sudden and permitted outgassing of dissolved CO_2.

According to media reports published at that time, an 80-meter fountain of foam shot out of the middle of Lake Nyos. A gas cloud separated from the fountain and rose up to a height of 125 meters. The gas cloud rapidly sank to the ground and spread over an area of up to 27 km from the lake. Within this region, only a few people and animals survived. Only those could escape death who had stayed in high-level places of the hilly area.

3.2 Carbon monoxide

The toxicity of carbon monoxide has played an important role in history. Already in the late period of ancient Rome, it was used as an effective execution method. Nowadays, it is a popular toxicant used for suicide in the Asian region. In recent years, the BfR has been informed of single cases of carbon monoxide poisoning. A slight increase was recorded in 2008. Altogether, 32 cases of carbon monoxide poisoning were reported that had occurred in indoor environments. In eight cases, the accidents were caused by defective gas boilers. In six cases, the BfR was informed of accidents in connection with indoor kart racing. Five reports referred to typical cases of poisoning as a result of fires in homes, and in one case, health complaints were reported due to a defective fireplace. For the first time, eleven cases of CO poisoning associated with charcoal grilling were recorded. These cases may have to be attributed to a lack of knowledge among the population about the hazard posed by carbon monoxide. On the one hand, a vast majority of homes has been equipped with modern central heating systems so that an important source of accidents has been eliminated and knowledge about the toxicity of carbon monoxide could have fallen into oblivion. On the other, grilling has become a popular activity, grill parties (barbecues) are held at any time of the year. To become independent of bad weather conditions, decorative “coal-fired” table grills for indoor use have recently become available. TV commercials feature charcoal grilling activities inside homes, suggesting a harmlessness of open fires in rooms lacking a direct exhaust system. A number of families, including some with children, had obviously misunderstood such advertising campaigns. They had operated their open charcoal grill indoors and used the residual heat of the grill as a heating source. In order to recall to mind the risk of carbon monoxide poisoning posed by indoor operation of open fires and to prevent a further propagation of such improper use, carbon monoxide has become the topic of this year's selected toxicological problems.

Carbon monoxide (CO) is produced by incomplete combustion of carbon-containing material, as e.g. during grilling with charcoal. If air supply is insufficient, as for example in closed rooms, the share of incomplete coal combustion is particularly high, resulting in an increased risk of CO poisoning. Carbon monoxide is odourless and therefore, not irritating. Hence, there will be no warning effect which can be perceived by humans. CO may accumulate in the environment by way of oxygen displacement. After inhalation, it is absorbed quickly by the pulmonary route, which is unnoticed initially. Carbon monoxide is haemotoxic and binds to the pigment (haemoglobin) of the red blood cells. The actual function of the latter consists in binding oxygen from the respiratory air and transporting it to all organs of the human body. As compared to oxygen, CO has an affinity to haemoglobin which is 200-250 times (in the foetus, 600 times) higher and therefore, displaces the oxygen from its haemoglobin binding. As a result, COHb is formed. Already at a carbon monoxide share of 0.1 % in the respiratory air, about 50 % of the red blood cells are blocked and not available for oxygen transport, and at a share of more than one per cent, death will occur within one to two minutes. In smokers, the CO contained in tobacco smoke

leads to an increased COHb level (5-10 % as compared to <2 % in non-smokers).

Under indoor air conditions, one half of the carbon monoxide is eliminated from the body within four to six hours. Under conditions of a 100 % oxygen supply, this will occur within 40-80 minutes, and under hyperbaric oxygen therapy, even within a mere 15-30 minutes. The German MAK (maximale Arbeitsplatzkonzentration – maximum admissible concentration at the workplace) for CO is 30ppm, a concentration of 1000 ppm is considered as lethal if inhaled over a period of 30 minutes.

The toxic effect is based on a combination of tissue hypoxia and a presumptive CO-specific damage at the cellular level. Foetuses and children are known to exhibit a much higher sensitivity to this pathomechanism. Often, the degree of severity of cases of poisoning is difficult to assess. Preceding treatment by e.g. oxygen supply may falsify measuring results and thus produce incorrectly low COHb concentration readings. Also, a protracted long-term exposure to low concentrations is more problematic than a short-term exposure to high concentrations. In cases of mild poisoning (COHb 10-20 %), patients will experience headache, dizziness, tinnitus, visual disturbance, vomiting, dyspnoea, weakness of muscles and tachycardia. Moderate to severe poisoning (COHb 20-60 %) is characterized by a bright red or pale/cyanotic skin colour. Initially, states of agitation will occur, followed by clouding of consciousness or even deep coma, convulsive seizures, cardiac arrhythmia and resulting collapse, superficial respiration or hyperventilation and metabolic acidosis. COHb concentrations of more than 70 % will lead to central anoxia and thus, to death within a few minutes. After having overcome the acute stage of poisoning, about 30 % of cases will develop delayed neurological manifestations with latency periods of 3 to 240 days. Opinions vary as to the reversibility of such manifestations.

The typical bright red colour of the skin in cases of moderate poisoning, persisting even in corpses, may lead to a misjudgement of the degree of severity of poisoning. Therefore, it has to be assumed that a considerable number of cases of CO poisoning remains undetected. Treatment will predominantly consist of a quick supply of ample amounts of oxygen as an antidote by means of a tightly fitting mask or, after intubation, by artificial respiration. It is the aim of such approach to increase the oxygen partial pressure to 500-600 mmHg. In cases of severe poisoning, which include patients with disturbance of consciousness and also pregnant women, hyperbaric oxygen therapy (HBO) in a pressure chamber is recommended. It should be initiated as early as possible. Initiation of therapy later than 6 hours after exposure has been regarded as no longer effective with regard to the prevention of late sequelae. The indication of HBO should be considered generously. HBO is recommended after prolonged exposure, in cases of metabolic acidosis, circulatory instability, ventilatory disorders, COHb >20 %, or in patients with pre-existing conditions, and it is even urgently required in patients with CNS manifestations such as disorientation or drowsiness. Patients affected should be transferred to a competent pressure chamber centre as quickly as possible. Other measures to be taken will include resolution of the acidosis, shock treatment to improve microcirculation, administration of corticoids to treat the inhalation trauma and prevention or treatment of cerebral oedema. In order to assess possible late sequelae, follow-up examinations (ECG, EEG, CT, MRI, neurological status, audiometry, fundoscopy) should be performed over a period of about one year.

3.2.1 Case reports associated with gas boilers

3.2.1.1 Carbon monoxide poisoning due to defective gas boiler: Six inhabitants of a house affected

Carbon monoxide had leaked from a defective gas boiler in the bathroom into a home. At that time, six persons were staying in the rooms of the home: the inhabitants, namely a family of five, and a guest who was there on a visit. All of them exhibited signs of poisoning and had to be treated in a hospital.

At the time of the accident, the parents were staying in the bathroom, and because of their direct exposure they were affected most severely. They were removed from the contaminated environment by their two elder children. When rescuing their parents, the children became massively exposed and as a result, also developed mild to moderate manifestations of poisoning. The third child and the guest showed minor complaints so that they as well had to seek medical attention at a hospital.

One and a half hours after the incident, members of the fire brigade measured the carbon monoxide concentration in the bathroom. As a result, a considerably elevated carbon monoxide concentration of at least 27 % was found.

Patient No. 1
The 41-year-old father of the family who had been staying in the bathroom when the accident happened became unconscious. Two of his children, a 16-year-old daughter and a 15-year-old son, removed him from the contaminated environment and brought him to safety. Subsequently, they called the rescue service. Having regained consciousness, the patient was in an agitated state. The emergency physician found him to be completely uncooperative so that sedation was required. As a result, respiratory insufficiency occurred which in turn required intubation. The patient's oxygen saturation was a mere 82 %. Measurement of the patient's carbon monoxide concentration by pulse oximetry on the scene of the accident revealed an elevated level of 25 %. The intubated patient was administered 100 % oxygen and transported to a hospital.

Manifestations/course
On admission to the hospital, the patient was intubated, being given artificial respiration equally on both sides, and sedated. Proprioceptive reflexes could not be triggered, no focal neurological deficiency was found. Miosis was found as a result of sedation with fentanyl. Clinical chemistry revealed an elevated CK of 488 U/l. The COHb level had risen to 23 % after artificial respiration with 100 % oxygen for about one hour.

The patient was transferred to a pressure chamber and immediately treated with hyperbaric oxygen at 2.8 bar, over 90 minutes, without paracentesis. After extubation, the patient was completely oriented, and no focal neurological deficiency was found. However, he complained of earache, tinnitus and impairment of hearing. He was therefore examined by ENT specialists, who found the tympanic membranes to be severely reddened with mild effusions as well as bilateral high frequency deafness. According to the consultants' recommendations, the patient was administered prednisolone i.v. over three days as well as mucolytics and decongestant nose drops. ENT follow-up examination resulted in noticeably improved findings, and the patient was found to be symptom-free. He could be discharged from hospital after five days of inpatient treatment. Onward outpatient therapy consisted of steroid administration at gradually reduced doses.

Given the neurological manifestations such as unconsciousness, agitation and respiratory insufficiency found after sedation, the degree of poisoning had to be rated as severe. This was also supported by the correspondingly high COHb level. In addition, it has to be taken into account that the latter had already been reduced as a result of preceding oxygen administration. The neurological manifestations required HBO. The course became complicated by a barotrauma, which has been frequently observed as an adverse reaction to HBO and was very pronounced in this case.

Evaluation of the case described
On the basis of the information given on the temporal relationship between carbon monoxide inhalation and the appearance of manifestations, and given the elevated blood level, a causal relationship has been confirmed.

Patient No. 2
The 38-year-old mother of the family had also been staying in the bathroom. She complained of most severe headache and inability to move. She was brought to fresh air by her 16-year-old daughter and her 15-year-old son. She remained conscious and was found almost fully capable of orientation. The emergency physician providing first aid administered hydroxocobalamine on the site as well as oxygen during transport to the hospital. In addition to a common cold with rhinitis at the time of the accident, the patient had also a history of bronchial asthma.

Manifestations/course
On admission to the hospital, the patient was awake, capable of orientation, but in an agitated and anxious state. All other findings on physical examination were normal. An elevated COHb level of 27 % was still measured although the patient had been administered oxygen for an hour. Clinical chemistry revealed mild leukocytosis (11 500/µL).

Based on the neurological manifestations found, it was decided to administer hyperbaric oxygenation (HBO) in the pressure chamber. However, such treatment had to be discontinued after a short period because of earache and the patient's inability to compensate pressure. In the further course, the patient was administered oxygen via a nasal tube until she became symptom-free. Her common cold was treated with mucolytics and saline inhalations.

She could be discharged after two days of inpatient treatment. Based on the neurological manifestations with concomitant agitation, the degree of poisoning in this case has to be rated as moderate. This was also supported by the correspondingly high COHb level. In addition, it has to be taken into account that the latter had already been reduced as a result of preceding oxygen administration. Based on the neurological manifestations, HBO was indicated which had to be discontinued early because of the preexisting common cold infection.

Evaluation of the case described
On the basis of the information given on the temporal relationship between carbon monoxide inhalation and the appearance of manifestations, and given the elevated blood level, a causal relationship has been confirmed.

Patient No. 3
The 15-year-old son of the family had helped his 16-year-old sister to remove their poisoned parents from the contaminated environment. Subsequently, he complained of severe headache and was disoriented. He

was brought to a hospital by the fire brigade. During transport, he received oxygen insufflation.

Manifestations/course
On admission to the hospital, the patient still complained of headache and nausea, but he was oriented with stable vital signs. The COHb level was slightly elevated, i.e. 4.5 % after the rescue (reference value <2 %), measured, however, under conditions of oxygen insufflation. Clinical chemistry revealed an elevated CK of 450 U/l (normal value <145 U/l) suggesting that CO poisoning had taken place. Based on the existing neurological manifestations which included disorientation, there was a clear indication for hyperbaric oxygenation. It was decided to administer HBO over 90 minutes at 2.8 bar. The further course was uncomplicated so that the patient could be discharged on the same day.

Given the neurological manifestations observed, the degree of poisoning has to be rated as moderate although the COHb level was only slightly elevated. It has to be taken into account, however, that the latter had already become reduced as a result of the preceding oxygen administration. Therefore, HBO was indicated, which was effective to render the patient symptom-free so that he could be discharged from the hospital soon thereafter.

Evaluation of the case described
On the basis of the information given on the temporal relationship between carbon monoxide inhalation and the appearance of manifestations, and given the elevated blood level detected, a causal relationship has been confirmed.

Patient No. 4
The 16-year-old daughter had first removed her severely poisoned parents from the contaminated environment and then called the rescue service. She herself made a tentative diagnosis of carbon monoxide poisoning. She had stayed in the contaminated area only during the rescue situation and later on complained of headache and nausea. The fire brigade brought her to a hospital, and during transport, she received oxygen insufflation.

Manifestations/course
On admission to the hospital, the patient still complained of mild headache. Findings on physical examination were normal. The COHb level was slightly elevated, i.e. 3.4 % after the rescue (reference value <2 %), however, after oxygen insufflation. Oxygen supply was continued until the patient was rendered symptom-free. She could be discharged on the next day.

Given the mild manifestations, the degree of poisoning has to be rated as minor. Also the COHb level was only slightly above normal. It has to be taken into account, however, that the latter had already been effectively reduced as a result of the preceding oxygen administration. It is unknown whether the patient was a smoker. HBO was not indicated, oxygen therapy was considered as sufficient.

Evaluation of the case described
On the basis of the information given on the temporal relationship between carbon monoxide inhalation and the appearance of manifestations, and given the moderately elevated blood level, a causal relationship has been confirmed.

Patient No. 5
Also the 8-year-old younger son of the family had stayed in the affected home. He was also brought to the hospital by the fire brigade and was administered oxygen during the transport for precautionary reasons.

Manifestations/course
The physical examination of the lively child did not reveal any pathological findings. However, the COHb level detected was slightly elevated to 3.4 % (reference value <2 %). Since the measurement was performed under oxygen insufflation, the initial level had most probably been higher. Clinical chemistry revealed an elevated CK of 221 U/l (normal value <170 U/l) CK as an indication that carbon monoxide poisoning had taken place. The patient was administered oxygen until he could be discharged after a few hours. Despite a lack of manifestations, this case has to be considered as a poisoning of minor degree due to the elevated COHb level. In all probability, this value had been higher prior to oxygen supply. HBO was not indicated, oxygen therapy alone was considered as sufficient. The boy could be discharged from hospital after a short time.

Evaluation of the case described
On the basis of the information given on the temporal relationship between carbon monoxide inhalation and given the elevated blood level detected, a causal relationship has been confirmed.

Patient No. 6
At the time of the accident, also a 30-year-old female guest had been staying in the carbon monoxide contaminated home on a visit to her relatives. She complained of headache for a short period only. She was also brought to a hospital by the fire brigade and was administered oxygen during the transport for precautionary reasons.

Manifestations/course
On admission to the hospital, the patient still complained of headache which, however, was about to subside. She was capable of local, temporal and situational orientation. The physical examination did not reveal any pathological findings. The COHb level measured was not elevated (1.4 %), however, under oxygen supply. Oxygen supply was continued until the patient was symptom-free. Subsequently, she could be discharged already after two hours of outpatient treatment.

This case of poisoning has to be rated as minor because the manifestations were mild and the COHb level not elevated. However, it has to be taken into account that the latter had been successfully reduced as a result of the preceding oxygen administration. HBO was not indicated, the patient was quickly rendered symptom-free by oxygen therapy alone. She required only outpatient treatment and could leave the hospital after a short time.

Evaluation of the case described
On the basis of the information given on the temporal relationship between carbon monoxide inhalation and the appearance of manifestations, and a blood level not elevated owing to oxygen supply, a causal relationship has been confirmed.

3.2.1.2 Carbon monoxide poisoning in a married couple due to defective gas boiler

Carbon monoxide had leaked into a married couple's home from a defective hot water gas boiler. The couple had been sleeping at that time. They reported to have woken up at about 4 a.m. feeling unwell. At first, the husband woke up, addressed his wife and became unconscious shortly afterwards. Also his wife lost consciousness for a short period. Subsequently, both were brought to a hospital by emergency service.

A measurement carried out by the professional fire brigade on the site detected an elevated carbon monoxide concentration. In order to find out the cause of the defect and to fix it, the district heating inspector and the gas watch were contacted. All homes of the apartment building were inspected. During these activities, it was found that two other persons living in the flat above the affected married couple had suffered mild carbon monoxide poisoning. Both required outpatient treatment. Altogether, four persons experienced symptoms of poisoning due to this defect.

Patient No. 1
The 21-year-old wife reported that she had already been suffering from sleep disorders recently. On admission to the hospital she was found in a good general condition and nutritional state, capable of temporal and local orientation, but clearly tired and lethargic. Findings of the orienting neurological examination were normal. Her heart rate was elevated (96/min), and oxygen saturation was 100 %. Toxicological analysis revealed an elevated COHb level of 20.8 %. No pregnancy was found. Because the patient had been unconscious, it was decided to administer hyperbaric oxygenation in the pressure chamber. The treatment was tolerated by the patient without any problems, her respiration and circulation were stable at any time. On the next day, she could be discharged in a condition of well-being and referred to her family doctor for further treatment.

Because of the neurological manifestations including unconsciousness, the degree of poisoning has to be rated as moderate. This was also supported by the correspondingly high COHb level. The neurological manifestations required HBO.

Evaluation of the case described
On the basis of the information given on the temporal relationship between carbon monoxide inhalation and the appearance of manifestations, and given the elevated blood level, a causal relationship has been confirmed.

Patient No. 2
On admission to the hospital, the 27-year-old husband was found in a good general condition and nutritional state, capable of temporal and local orientation and still tired. Findings of the orienting neurological examination were normal. Oxygen saturation was 99 %. Toxicological analysis revealed an elevated COHb level of 25.1 %. Because the patient had been unconscious, it was decided to administer hyperbaric oxygenation in the pressure chamber. The treatment was tolerated by him without any problems, his respiration and circulation were stable at any time. On the next day, the patient could be discharged in a condition of well-being and referred to his family doctor for further treatment.

In this case, the degree of poisoning has to be rated as moderate because of the neurological manifestations including unconsciousness. This was also supported by the correspondingly high COHb level. The neurological manifestations required HBO.

Evaluation of the case described
On the basis of the information given on the temporal relationship between carbon monoxide inhalation and the appearance of manifestations, and given the elevated blood level, a causal relationship has been confirmed.

3.2.2 Case reports associated with grilling

A Poison Control Centre had recorded a cluster of cases of carbon monoxide poisoning associated with indoor grilling in homes and therefore, informed the BfR about the risk involved.

3.2.2.1 Carbon monoxide poisoning in a large family after indoor grilling

A large family with seven children had planned a grill party in the open. Because of the rainy and cool weather prevailing at that time, the charcoal grill was brought indoors into the living room in order to use it simultaneously as a heat source. The family had taken this idea from a TV commercial propagating such action. One of the children as well as the parents had to be treated in a hospital for carbon monoxide poisoning.

Fig. 9: Charcoal

Patient No. 1
In April 2008, the 3-year-old disabled child of the family had been presented to a paediatric hospital in order to examine in detail the causes of the child's retardation which had been present already for an extended period of time. Examinations revealed an elevated COHb level of 24.5% as an incidental finding. It turned out that the family had been grilling indoors in the evening before so that the elevated COHb level could be attributed to this activity. With a balanced pH and a base excess of minus 3.2, the patient's acid-base status was found to be within the normal range. No manifestations other than vomiting were found. Because of the preexisting retardation, the patient's vigilance could be assessed with reservation; it did not appear to be reduced. The paediatric hospital contacted a Poison Control Centre for information on how to proceed in this case. Admission to hospital was recommended to administer hyperbaric oxygenation (HBO). The BfR has not been informed about the further therapy and the course, particularly whether HBO was administered or not.

In this case, the degree of severity of health disturbance has to be rated as moderate due to the moderately elevated COHb after extended exposure, although the patient exhibited only relatively few manifestations and the acid-base status was still balanced. In similar cases, HBO could be indicated (also because children are particularly sensitive to CO) and effective if the treatment is initiated early.

Evaluation of the case described
On the basis of the information given on the temporal relationship between carbon monoxide inhalation and the appearance of manifestations, and given the elevated blood level, a causal relationship has been confirmed.

Also the parents of the family complained of symptoms such as nausea and headache during the night. Because such complaints are typical of the clinical picture of carbon monoxide poisoning, they were associated with the indoor grilling activity. Therefore, the parents were advised by the PCC to present to a hospital for diagnosis and therapy.

Patient No. 2
On admission to hospital on the next day, the patient only complained of mild headache. No disturbances of consciousness were found. With a pH of 7.44, his acid-base status was initially balanced. No acidosis was found. However, a conspicuous increase in COHb

to 26 % was found. Therefore, the patient was administered oxygen by nasal intubation. Such therapy resulted in a reduction of COHb to a normal level of 5 %. Given the mild manifestations, the degree of severity of poisoning has to be rated as minor in this case, although the COHb level had risen to more than 20 %. It is unknown whether the patient was a smoker.

Evaluation of the case described
On the basis of the information given on the temporal relationship between carbon monoxide inhalation and the appearance of manifestations, and given the elevated blood level, a causal relationship has been confirmed.

Patient No. 3
On admission to hospital, the female patient only complained of a mild headache. No disturbances of consciousness were found. With a pH of 7.39, her acid-base status was initially balanced. No acidosis was found. However, a conspicuous increase in COHb to 23 % was found. Therefore, the patient was administered oxygen by nasal intubation. Such therapy resulted in a reduction of COHb to a normal level of 4.7 %. Given the mild manifestations, the degree of severity of poisoning has to be rated as minor in this case, although the COHb level had risen to more than 20 %. It is unknown whether the patient was a smoker.

Evaluation of the case described
On the basis of the information given on the temporal relationship between carbon monoxide inhalation and the appearance of manifestations, and given the elevated blood level, a causal relationship has been confirmed.

3.2.2.2 Carbon monoxide poisoning in two children of a family after indoor grilling

Already one night before, the poison emergency telephone service had been consulted because of the same problem. A 14-year-old child had to be admitted to a paediatric hospital together with a 3-year-old sibling after a glowing charcoal grill had been brought indoors in order to use the residual heat.

Patient No. 1
During the night, the parents noted a tendency towards collapse and central nervous manifestations such as drowsiness in the 3-year-old child. Because such manifestations were suspected to have been caused by carbon monoxide poisoning due to the preceding indoor operation of a charcoal grill, the child was brought to a paediatric hospital. During transport, the child was administered four liters of oxygen. Except for the tendency towards collapse and drowsiness, no other manifestations were stated. No acidosis was found. However, the COHb level was elevated (17.4 %). No complications occurred in the further course. The child became asymptomatic so that no other measures were required.

Based on the elevated COHb level after preceding oxygen administration and the CNS manifestations observed, the degree of severity of poisoning has to be rated as moderate in this case. It has to be assumed that the patient's initial COHb level had been elevated already prior to the treatment. The rapid initiation of therapy could effectively prevent the appearance of other manifestations and thus, a severe poisoning. HBO was not required.

Evaluation of the case described
On the basis of the information given on the temporal relationship between carbon monoxide inhalation and the appearance of typical

manifestations, and given the elevated blood level detected, a causal relationship has been confirmed.

Patient No. 2
Also the 14-year-old child of the family had to be admitted to a paediatric hospital together with the 3-year-old sibling. During transport, the child was administered four liters of oxygen. Examinations made on admission found the child to be symptom-free. No acidosis was found. However, the COHb level was elevated (16.3 %). No complications occurred in the further course so that other measures were not required. Despite a lack of manifestations and based on the elevated COHb level detected after preceding oxygen administration, this case has to be rated as one of minor poisoning. It has to be assumed that the COHb level had been even higher prior to treatment. Also in this case, the development of pronounced manifestations was prevented by a rapid initiation of therapy.

Evaluation of the case described
On the basis of the information given on the temporal relationship between carbon monoxide inhalation and given the elevated blood level detected, a causal relationship has been confirmed.

3.2.3 Case report associated with kart racing

3.2.3.1 Carbon monoxide poisoning from indoor kart racing

During an event at an indoor kart circuit, a death occurred which initially was associated with the stay at that kart hall. An experienced toxicologist considered carbon monoxide poisoning caused by a defective ventilation system as possible. Measurements performed by the German TÜV (Technischer Überwachungsverein – Technical Inspection Association) did not reveal any elevated carbon monoxide concentrations in the indoor air of the hall. However, increased COHb levels of 4 to 17 % (normal value 2 % and less) were found in the blood of all 14 staff members in the evening i.e. at the end of their working day. As a precautionary measure, a radio call was broadcast to the population recommending that all persons who had been exposed and were experiencing complaints should see a physician to reassure themselves. According to media reports, this resulted in a total of 48 persons calling at hospitals for medical advice.

On the same day, a 31-year-old patient had visited the indoor kart circuit in his leisure time. When the kart races had finished, he stayed for a lunch break at a grill station in the entrance area. Until that time, he had been feeling well. About 10 to 15 minutes after the meal, the patient developed increasing headache, vertigo, nausea and sweating. Therefore, he left the closed and poorly ventilated hall after having stayed there for six and a half hours and went home. Also the patient whose case is described in the present report therefore presented to the toxicology department of a hospital in the evening of the same day. The patient was a non-smoker, he had not been suffering from chronic headache nor migraine before and was not taking any regular medication.

Manifestations/course
On admission to the hospital, the patient was fully capable of temporal and local orientation. No disturbances of consciousness were found. Conspicuous findings included facial reddening, an increase in body temperature to 37.8 °C as well as hypertension of 178/113 mm Hg. The patient's heart rate was 90/minute, and his oxygen saturation level under indoor air conditions showed a normal value

of 100 %. The COHb level measured by CO oximetry six hours after the patient had left the indoor kart circuit was still as high as 6.4 % (normal value <2 %).

Clinical chemistry revealed an elevated creatine kinase level (255 U/l, normal value up to 145 U/l), which in the further course decreased (187 U/l). This level had probably resulted from the preceding physical activity. In addition, the patient had developed leukocytosis of 9 590/µL, which in the further course increased to 20 620/µL.

Treatment was based on the manifestations observed and included oxygen supply and administration of paracetamol. As a result, a rapid improvement of the patient's condition was observed. The COHb level measured on the following day was 1.1 %, i.e. within the normal range. Because the patient had insisted on leaving the hospital, he was discharged on the following day.

Notes
In 2008, the BfR was informed for the first time of cases of carbon monoxide poisoning associated with indoor kart racing. Three of the six cases reported had a mild course and the other three, a moderate course. The latter patients had to be administered hyperbaric oxygen therapy.

In the case referred to in this report, the patient experienced the typical symptoms of carbon monoxide poisoning. Given the mild manifestations observed, the degree of poisoning has to be rated as minor. Also the COHb level was only slightly above normal. However, it has to be taken into account that the latter was measured as late as six hours after discontinuation of exposure and that the initial level had most probably been higher.

Evaluation of the case described
On the basis of the information given on the temporal relationship between carbon monoxide inhalation and the appearance of manifestations, and given the moderately elevated blood level, a causal relationship has been confirmed.

3.3 Other cases reported in 2008

3.3.1 Death after suicidal ingestion of 2,4-dinitrophenol (DNP)

Starting in the afternoon after a Chinese meal, a 24-year-old patient had been suffering from increasing nausea, discharge of liquid black stools, sweating and dyspnoea. He measured his body temperature which had risen to 40 °C. In the further course it turned out that he had ingested 2 capsules of dinitrophenol, allegedly as a self-experiment. He stated to have erroneously taken a wrong dose, i.e. instead of 100 mg capsules, as initially stated by his partner, he had ingested 2 g capsules. However, the reason for the ingestion had probably been suicidal intent because, as was reported later by the patient's mother when asked for the medical history, he had been suffering from psychosis.

The young male patient himself contacted a Poison Control Centre, and he was recommended to immediately present to a hospital. Accompanied by his female live-in partner, he therefore presented to the emergency unit of a hospital four hours after ingestion, however, without mentioning the DNP ingestion. The patient also mentioned a history of persistent hypothyroidism.

Manifestations/course
At the emergency unit, the patient showed excessive sweating, his clothing was soaked by sweat and he complained of an increasing sensation of heat. His axillary body temperature was 37 °C. Findings made on admission

included a slight scleral icterus and a reddening of the skin of his head and trunk. The patient was tachypnoeic and dyspnoeic, respectively, and seen to be in a highly agitated state. Neurological examination did not reveal any abnormalities. Auscultation revealed an increased heart rate expressed in the ECG as a sinus tachycardia of up to 137/min. Chest X-ray showed no abnormality. Oxygen saturation was 100 %. Clinical chemistry revealed an elevated CK of 1464 U/l and a minor-degree respiratory alkalosis of pH 7.459. Electrolytes were balanced.

Altogether, examination and treatment of the patient were difficult because of his indignant and aggressive behaviour. To control his pronounced agitation, the patient was administered lorazepam by the oral route, which was followed by immediate vomiting. In the further course, vomiting intensified and recurred at shorter and shorter intervals. I.v. administration of diazepam resulted in a mild sedation.

The patient had stated to regularly take medication to control acne (vitamin A acid). Although repeatedly asked by the hospital physicians, he denied having consumed other medicines, narcotic drugs, food supplements, or alcohol. However, in August 2006, he had undergone withdrawal treatment for abuse of pharmaceuticals (testosterone and bronchodilatators). In 2007, he had experienced benzodiazepine poisoning, and a history of chronic anabolic and nicotine abuse was known. More than 90 min after admission, the patient's partner reported that the patient had taken two capsules of dinitrophenol (2 g each, as turned out later) in the early afternoon. She stated that this had been a self-experiment and performed for the first time. However, it was revealed later on that the patient had suffered DNP poisoning already in January 2007 and was well experienced in handling this substance. Allegedly, he had written an article on DNP and published it on the internet.

The hospital consulted the poison emergency telephone for advice. After the hospital had obtained information about the high toxicity of the substance and the risk of critical poisoning, the patient was transferred to another hospital because of lacking facilities for intensive care. On admission, the strikingly muscular patient was in an acutely reduced general condition, otherwise characterized by a very low cutaneous fat share and an athletic nutritional constitution. He was awake, capable of orientation and still agitated and aggressive. He stated that he had not taken the preparation with suicidal intent but had erroneously taken a wrong dosage. He also stated that he had written a MA thesis on 2,4-dinitrophenol and was aware of his life-threatening situation. He did not provide any information on the origin of the preparation. The patient was suffering from resting tremor and profuse sweating all over his body, he stated to have a pronounced sensation of thirst and wanted to drink cold fluid. His body temperature was 39 °C. He also asked to be administered activated charcoal. Meanwhile, his heart rate had reached 170/min, his blood pressure was slightly elevated at 140/50 mm Hg. After i.v. administration of a beta blocker, the heart rate decreased to 130/min and the blood pressure returned to normal. The patient remained markedly tachypnoeic, with respiratory rates of 40-50/min. Oxygen saturation was 100 % under conditions of oxygen supply (2 l). Clinical chemistry revealed leukocytosis of 14 900/µL, hypochromic erythrocytes, slightly elevated GPT of 45 U/l (normal up to 30 U/l), hyperglycaemia of 176 mg/dl (normal up to 110 mg/dl), elevated CK of 1429 U/l (normal up to 145 U/l) with normal CKMB, massively elevated potassium levels with a

maximum of 9.7 mmol/l (normal up to 4.8 mmol/l), and increasingly severe lactacidosis with lactate levels of up to 19 mmol/l (normal up to 0.9 mmol/l) and a minimum pH level of 7.132.

After consultation of Poison Control Centres in Berlin, Bonn and Mainz, administration of active charcoal was omitted in this case because of its lack of effectiveness. Instead, a symptom-oriented therapy was initiated comprising forced cooled volume replenishment as well as external cooling by means of several cooling elements. Since the patient quickly developed both mental and respiratory exhaustion he was subjected to intubation and artificial respiration after initial sedation with midazolam. He was given a maximum of intensive medical care including implantation of a central venous catheter (CVC), an arterial blood pressure measuring cannula, a urinary catheter and a gastric tube. In spite of these measures, the patient developed an increasing acidosis in the further course, with an increase in potassium levels that could not be reduced by administration of calcium gluconate, sodium bicarbonate and glucose infusions together with insulin. Rhabdomyolysis and hyperthermia occurred in addition. According to the recommendations given by the Mainz Poison Control Centre, the patient was subjected to deep sedation and muscle relaxation and the existing hyperthermia treated with dandrolene. He developed prerenal failure associated with dehydration. Because of the increasing potassium levels, it was decided to place a dialysis catheter for haemofiltration. Nevertheless, the patient developed bradyarrhythmia soon followed by cardiac arrest, which required cardiac massage. Even extreme critical care medication could not prevent the progression of lactacidosis as well as the quick development of pronounced muscular rigidity of the entire body so that resuscitation efforts had to be discontinued about 9 hours after the DNP ingestion. Because of the unnatural cause of death, the criminal investigation department was informed.

Notes

2,4-dinitrophenol is a lipophilic substance belonging to the substance group of nitrophenols. All substances of this group are highly toxic and may cause poisoning by the inhalational, dermal and oral routes. DNP, in particular, is assumed to have embryotoxic, carcinogenic and mutagenic effects.

DNP was used for the first time already in 1919, namely in France to produce ammunition. Workers in factories producing explosives who suffered from health disorders such as attacks of dizziness, sweating and headache were also found to lose body weight. This resulted in the idea that overweight might be treated by administering DNP. However, in 1938, it became known that DNP administration involved considerable risks such as the formation of cataract associated with a yellow-brownish discoloration of the ocular lenses. As a consequence, DNP was withdrawn from the US market as a pharmaceutical product for weight reduction. Later, DNP was used as a wood preservative, a photochemical and a pest control agent.

In the 1980ies, a Texan physician rediscovered the substance and sold a product for weight reduction that contained DNP. The death of a wrestler treated with this product was followed by an investigation, which resulted in DNP being banned again as a pharmaceutical product for weight reduction. Up to the present, no food supplement or pharmaceutical product containing DNP has been approved by the US Food and Drug Administration (FDA).

DNP uncouples oxidative phosphorylation. The high-energy molecules for ATP synthesis con-

tinue to be delivered but they are converted to heat instead of ATP. This elicits an intensive thermogenesis associated with a drastic increase in body temperature. Because ATP formation has come to an end, the body uses other resources for energy production and reduces body fat. The liver will release glucose as an alternative ATP source. This anaerobic degradation process causes the formation of lactate and ethanol as end products resulting in the development of metabolic acidosis. The lethal dose is stated to be of 1-3 g DNP (single dose). The details of pharmacokinetics are unknown, however, the half-life period of the substance seems to permit its accumulation. This is suggested for example by the death of a bodybuilder who took a daily dose of 600 mg DNP for four days and died on the fifth. Probably, many deaths due to DNP have to be attributed to the fact that the cumulative effect had not been taken into account. DNP is a highly toxic substance. Manifestations of poisoning with this substance include hypotension, tachycardia, cardiac arrhythmia, sudden cardiac death, dyspnoea, aspiration pneumonia, lung oedema, headache, agitation, cerebral oedema, coma, hyperthermia, dehydration, metabolic acidosis, rhabdomyolysis, thyroid dysfunction, hyperglycaemia, gastrointestinal disorders, cyanosis, haemolytic anaemia, methaemoglobinaemia, agranulocytosis, yellowish discoloration of skin, sperm and the ocular lenses associated with cataract formation, renal insufficiency, hepatic failure and finally, multiple organ failure. There is no known antidote. Therapy concentrates on external and internal cooling and is symptom-oriented. In cases of ingestion of lethal doses, the patient's life cannot be saved, as a rule, in spite of invasive intensive medical measures, i.e. in the majority of such cases, the prognosis is unfavourable.

Results of investigations at the German Sport University, Cologne, have indicated that DNP has been massively advertised as a fat burner for effective weight reduction. The substance is very cheap and can be obtained relatively easily from companies trading in chemicals. It might also be used as an anabolic steroid to accentuate the muscles after body fat reduction, an effect utilized by the patient whose case is described.

In this case, a lethal dose of 2 g had been ingested. Pathognomonic signs such as excessive sweating, hyperthermia and lactacidosis occurred in addition to typical symptoms such as gastrointestinal complaints, dehydration, tachycardia with cardiac arrhythmia, dyspnoea, hyperglycaemia, rhabdomyolysis and renal insufficiency. Signs such as the scleral icterus, the accentuation of muscles in the patient's general physical appearance, his low cutaneous fat share and the existing thyroid dysfunction point to a long-term use of the substance.

Evaluation of the case described
Based on the information on the temporal association between the intake of a lethal dose of DNP and the appearance of typical manifestations, a causal relationship has been considered as probable in the case described.

3.3.2 Occupational dermal exposure to bromine

During a chemistry lesson, a 36-year-old teacher had spilled bromine over her hand after an experiment. The odour she perceived as a nuisance was moderate. About one hour later, she presented to a toxicological outpatient clinic. She complained of minor local pain.

Manifestations/course
Inspection of the patient's hand revealed some reddish lesions (ca. 3 cm in size) on her middle and ring fingers. In addition, blisters of ca. 1 cm in size were found at these sites having a brown colour characteristic of bromine. All other findings on physical examination were normal.

The patient was provided topical treatment with a highly diluted sodium bicarbonate solution in which her hand was immersed. Afterwards, she was discharged and returned to her home. In addition, she was given cortisone "milk" (lotion) for application at home, and she was on sick leave for one day. Follow-up examination findings showed an improvement of the local lesions.

Notes

Bromine is a halogen and was isolated for the first time from marine algae in 1826. Production on a technical scale started in 1860. Due to its pungent odour, it was named after the Greek word "bromos", meaning the stench characteristic of he-goats. Bromine is a dark red-brown and heavy liquid characterized by a high reactivity. On contact with air, it forms markedly red-brown and pungent vapours, which are five times heavier than the latter and therefore, accumulate on the ground. It is used as a disinfectant and a medicine (narcotic, sedative and soporific, anticonvulsant), among a variety of other uses. It has to be stored in containers made from glass, lead, monel (a copper/nickel alloy) or nickel because coatings, rubber and plastic materials would be attacked and become corroded. The substance may be absorbed by the oral or the inhalational route. Oral or inhalational exposure will cause cough, dyspnoea, headache, dizziness, chemical burns, abdominal cramps, circulatory disorders and collapse. Inhalation of the irritant gas having a moderate water solubility may result in toxic pulmonary oedema, after a latency period. Due to the substance's caustic effects, a direct contact with the skin may cause badly healing wounds and produce reddening of and pain in the eyes.

Exposed persons should quickly leave the gas-contaminated area. Other measures include sedation, if required, and protection against a loss of body heat. Contaminated clothes should be removed and the affected skin areas thoroughly rinsed with water. There is no special therapy. Presentation to a physician is recommended. Patients developing manifestations such as cough should be observed in a hospital setting because a development of toxic pulmonary oedema after a latency period cannot be excluded. As a preventive measure, these patients should therefore be administered a glucocorticoid as soon as possible, either by means of a CFC-free metered-dose inhaler (e.g. budesonide) with aerosol holding chamber or if a massive exposure is assumed to have taken place, by i.v. injection of high doses (preferably of methylprednisolone). Onward therapy will be oriented by the symptoms. Precautionary measures include the protection of the skin and the eyes with appropriate protective materials. Personal safety measures should include full protection by wearing gas-tight clothing.

From the dangerous substances reported to the BfR, bromine is the toxic agent most frequently involved in school accidents (> 20 %). Altogether, 106 reports of cases involving bromine have been submitted to the BfR so far. Typically, such poisoning accidents resulted in series of cases because commonly, many persons, frequently entire school classes, were affected. In the school accidents, the cause was always a glass bottle which had fallen down and broken on the floor. Therefore, in all these cases, bromine intake took always place by the inhalation route. As mentioned above, glass containers are needed for storage because unbreakable plastic containers would be attacked by the substance. In cases reported to the BfR, the majority of persons affected (67 %) experienced mild symptoms like those in the case described above. Typically, breathing difficulty (ca. 70 %) predominated, followed by nausea and headache (almost 50 %). The majority of patients was observed as inpatients in a hospital setting, and all of them, except for one patient who had no manifestations, saw a doctor. Owing to quick and effective therapeutic measures, severe

poisoning resulting in pulmonary oedema or irreversible health damage could be prevented.

Evacuation measures and medical care required after such incidents involve high expenditure on labour and other costs. Storage of the chemical in unbreakable containers (e.g. monel) could probably help to prevent such accidents in the future.

Evaluation of the case described
Based on the temporal relationship between the exposure and the appearance of symptoms, a minor phosgene poisoning has been rated as probable.

3.3.3 Ethylene glycol poisoning from suicidal ingestion of an antifreeze coolant

A 20-year-old patient had ingested, with suicidal intent, a relatively large amount (ca. 700 ml) of an antifreeze coolant containing mainly ethylene glycol, which is a toxicologically relevant substance. Therefore, he was admitted to the nearest hospital. The only information available regarding the further course of the poisoning after admittance to hospital was that about the patient having developed metabolic acidosis which was difficult to treat. For onward treatment, he was transferred to the toxicological department of a specialized hospital.

Manifestations/course
On admission to the specialized hospital, the patient gave a very frightened impression. Nevertheless, he was completely capable of temporal and local orientation. He complained of nausea. Findings on admission included a reduced general condition, moderate tachycardia of 110/min and a pale and cold skin. Blood pressure was within normal limits (131/72 mm Hg), the respiratory rate was 20/min. The toxicological analysis of the blood sample collected at the first hospital revealed a markedly high ethylene glycol level of 1.3 mg/ml in the blood serum. Determination of the serum level performed later, i.e. at the time of the patient's admission to the toxicological department, had already been negative. Clinical chemistry revealed pronounced metabolic acidosis with a pH of 7.296 (normal 7.35-7.45), pCO_2 18.1 mm Hg (normal 35-45 mm Hg), pO_2 31.8 mm Hg (normal 70-100 mm Hg), a standard bicarbonate of 8.6 mmol/l (normal 22-26 mmol/l) and a base excess of -15 mmol/l (normal –3.0 to +3.0 mmol/l) as well as elevated lactate of 3.4 mmol/l (normal up to 0.9 mmol/l). In addition, a mild leukocytosis of 12,170/µl was found. Creatinine was within normal limits (0.9 mg/dl). Microscopic examination of urine collected on the day of admission revealed uric acid crystals which presented in the sediment as calcium oxalate crystals. Oxalosis is a pathognomonic sign of ethylene glycol poisoning. Onward treatment included resolution of the acidosis and antidote therapy with fomepizole. This regimen resulted in an improvement of the patient's somatic condition. In the serum, ethylene glycol could no longer be detected but instead, the typical oxalate crystals were found as a sign of renal damage.

Psychiatric consultation revealed a continued latent suicidality in the patient due to a depressive syndrome. In agreement with the psychiatrist, an antidepressive therapy with fluctin was initiated and onward treatment at a department specialized in child and juvenile psychiatry recommended. After four days of treatment at the toxicological department, the patient was therefore transferred to a psychiatric department for onward psychotherapy.

Notes
Ethylene glycol is a colourless and odourless fluid with a pleasant and sweet taste. It is used as an antifreeze, e.g. for car radiators, and for a

number of other purposes. In the event of oral ingestion, it is absorbed readily and completely. A 25 % share of the ethylene glycol absorbed will remain unchanged and is excreted by the renal route, while a 75 per cent share will undergo oxidation by the hepatic alcohol dehydrogenase (ADH) to form glycolaldehyde and subsequently, glycolic acid. The mean biological half-life is 4.5 h. A minor share of the glycolic acid will undergo further oxidation to oxalic acid, which is excreted by the renal route. Above all, formation of the toxic metabolites, glyoxalic acid and glycoaldehyde will result in damage to the CNS, liver, kidneys, lungs and heart. The formation of organic acids will lead to severe acidosis. There may be a deposition of oxalates in the walls of small vessels (brain and kidneys). Above all, crystal formation in the renal tubules will cause renal failure due to clogging (oxalosis). The toxic dose has been stated to be 0.1 ml/kg body weight, the toxic plasma level, 0.1 mg/ml.

Manifestations are characterized by four phases:

- Central nervous, gastrointestinal and metabolic manifestations: within a period of between a few minutes and 12 hours after ingestion involving drunkenness (in the absence of alcohol foetor), somnolence which may develop into coma, agitation, nystagmus, convulsions, nausea, vomiting, abdominal complaints, metabolic acidosis.
- Cardiorespiratory manifestations: within a period of 12-14 hours after ingestion involving dyspnoea, tachypnoea, mild hypertension and arrhythmia, pulmonary oedema, circulatory failure.
- Renal manifestations: within a period of 24-72 hours after ingestion involving oliguria, creatinine increase, proteinuria, haematuria, oxaluria, renal failure due to acute tubular necrosis and cerebral oedema.
- Central nervous manifestations: within several days after ingestion involving bilateral peripheral facial palsy, increase of cerebrospinal protein levels, anisocoria and visual disturbance, hyperreflexia, ataxia, dysphagia and vomiting.

Fig. 10: Antifreeze coolant

Since the toxicant is absorbed quickly, its primary removal is meaningful as a therapy only within the first hour after ingestion. Because charcoal has a low binding capacity, its administration is ineffective and therefore not indicated. As an antidote, ethanol is administered. Its principle of action is a blocking of the ethylene glycol metabolism on the basis of a higher affinity for ethanol of the alcohol dehydrogenase. Thus, the latter is no longer available for the metabolism of ethylene glycol, which will prevent the formation of toxic metabolites and result in the elimination of the non-toxic ethylene glycol in unchanged form. For a couple of years, experience has also been gained with administration of the highly effective alcohol dehydrogenase inhibitor, 4-methylpyrazole (fomepizole) as another antidote alternative to ethanol. However, it is less often used than ethanol for economical reasons. The frequent presence of extremely severe acidosis may require administration of high doses of 1M sodium hydrogen carbonate as a symptomatic measure. In cases of uncontrollable acidosis or plasma levels of 0.5 mg/ml and above, early haemodialysis is recommended as an effective measure for secondary detoxification, in addition to the antidote therapy. Decisive importance has been attributed to

an early initiation of therapy, which may have a considerable influence on the course of the poisoning.

In the above case, the patient was not administered an antidote initially. Actually, the high initial ethylene glycol level would have required antidote administration and haemodialysis. Because such treatment was omitted, the ethylene glycol could undergo uninhibited degradation to its toxic metabolites which caused severe acidosis. In the further course, the degradation products crystallized in the renal tubules, and characteristic oxalate crystals were found in the patient's urine. When ethylene glycol testing had been negative, administration of an antidote and haemodialysis were no longer required.

Evaluation of the case described
Based on the information given on the temporal relationship between the ingestion and the development of typical manifestations (acidosis, oxalate crystals), together with the detection of high ethylene glycol levels in the blood, a causal relationship has been confirmed in the case described.

3.3.4 Incomplete healing after severe chemical burn of the skin and bone damage allegedly associated with the use of a household cleaner

A 67-year old female pensioner had bought a commercial household cleaner from a drugstore and used it for the first time to clean her bathtub. She explained later that when doing the job, she had used only her right hand, and foam produced by the cleaner had run over her hand. After termination of the cleaning process, she thoroughly washed her hands with clear water. Initially, she did not notice any changes on her hand nor did she experience any complaints. Three days later, she suddenly felt a strong burning sensation on the back and the fingers of her right hand. In order to soothe the pain she ran cold tap water over her hand. This was followed by big blisters forming on the back of her hand and her fingers. Therefore, she immediately sought assistance at the emergency ward of the nearest hospital.

Manifestations/course
When she presented at the hospital, findings included swelling and blisters on the back and the third and the fourth fingers of her right hand. Since an allergic reaction was suspected, she was administered prednisolone and fucidinic acid. She did not state any potential cause of the skin damage and in particular, denied having experienced any trauma or accident. She refused to present at a specialized dermatological hospital for onward treatment as well as admission for inpatient treatment.

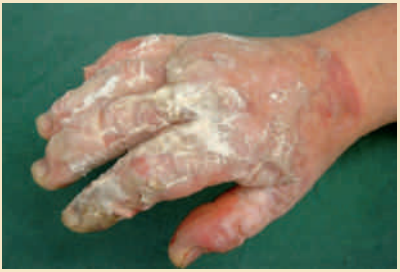


Fig. 11: Initial findings

One day later, she presented again at the hospital emergency ward. The blisters were opened and treatment with prednisolone and fucidinic acid was continued. Now, the patient stated to have used a multi-purpose cleaner product. On the next day, she returned to the emergency ward, and therapy was continued as before.

Three days later, the patient consulted a surgery practitioner in her home town. The back and all fingers of her right hand showed

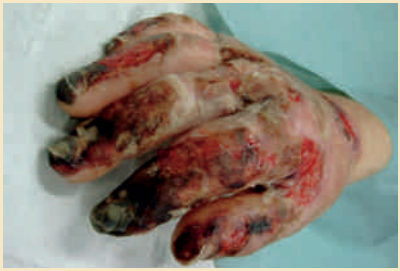


Fig. 12: Course – Back of the hand (nekrosectomy, skin grafts)

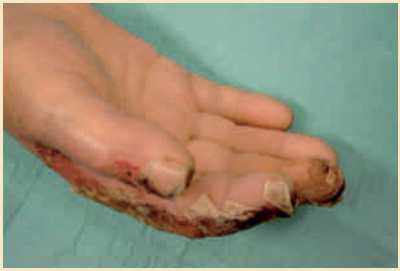


Fig. 13: Course – Palm of the hand

major swelling and were partly covered with blackish coatings. Fingertips were whitish and swollen. After opening of the blisters, massive skin defects were seen. These were covered with porcine grafts. The grafts were exchanged repeatedly and finally replaced by autografts.

In the further course, complications occurred due to infection and increasing necrosis. After a resistogram had been established, the patient was administered levofloxacin over 10 days and sodium chloride baths as a topical treatment of her hand. Necrotic tissue had to be removed at weekly intervals under general anaesthesia. Strikingly, progressive necrosis developed on the distal phalanxes of the second, third and fourth fingers. Findings included cicatricial changes on the right hand with irregular skin structure in the region of the back of that hand. The fingers exhibited

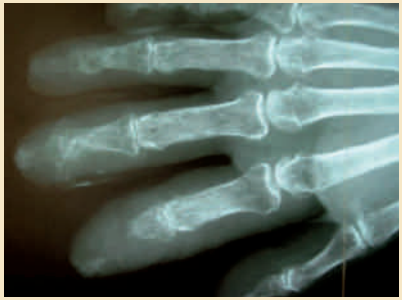


Fig. 14: X-ray picture revealing a total lysis of the distal phalanx of the right index finger

cicatricial changes on their back. Movement of the thumb showed a minor functional impairment while no movement deficit was found to be present in the other fingers. The nails of the second, third and fourth fingers were found to be necrotic while those of the thumb and the small finger were intact. Strikingly, the entire palm of the hand had remained unaffected, showing a completely normal appearance.

X-ray examination of the hand revealed a complete destruction of the distal phalanx of the right index finger due to total lysis, which eventually required amputation of the distal phalanx affected. Subsequently, the patient developed cicatricial contracture in the region of the knuckle joints of the thumb and index finger. However, the patient

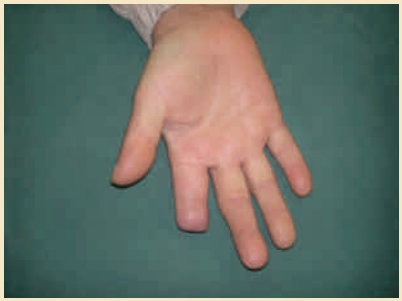


Fig. 15: Final condition after partial amputation

refused to do physiotherapeutic exercises or to wear splints.

Nail material was sent to a forensic institute for toxicant analysis. In addition, histological preparations from bone material of the removed distal phalanx of the finger have been retained. No results have become known so far. The patient suspected that her skin and bone injuries had to be attributed to the use of the household cleaner and claimed compensation from the manufacturer for the permanent physical damage she had suffered. To this aim, she gave an account of her experience to a TV station, which reported on the case. The BfR was informed about this case by an inquiry from the media, conducted investigations in the context of the compulsory reporting system and evaluated the divergent findings (status as of June 2008).

Notes

So far, the BfR has not received any reports under §16e ChemG referring to health complaints associated with the product involved. The product involved is a common household cleaner having a pH of about 11. All of its ingredients such as dimethyl dodecylamine oxide, propylene glycol monobutyl ether and ethanol, as well as complexing agents and essential oils are well known. The corrosive chemicals, monoethanolamine and sodium hydroxide, are contained in very low and therefore safe concentrations (<5 % and <1 %, respectively). The assumption of alkaline burn was also ruled out on account of the surgical findings which included intact structures of the tissue and ligaments not typical of colliquative necrosis. In addition, the dynamics of the course did not comply with that typical of chemical burns due to a household cleaner. As a rule, manifestations of chemical burns will develop within a few minutes to hours, whereas a latency period of three days is inexplicable.

The possibility that the product had been contaminated or another product had been mistaken for it could be excluded by an analysis of the sample provided by the patient herself. The results corresponded to the specification so that a deviation from the product composition could be excluded. Experimental direct contamination using the identical product performed by a member of the manufacturer's staff showed that on healthy skin, contact over a period of one hour (without rinsing) was tolerated without producing any reaction. Even when the same experiment was repeated over an extended contact period of 12 hours, no skin reaction was seen. Another striking feature is seen in the fact that the region affected by the injury, i.e. the back of the hand, is rather typical of exposure due to e.g. overflowing liquids, but not due to immersion or working with the entire hand. Therefore, it has to be assumed that the exposure did not take place during the cleaning operation but as a result of overflowing. Likewise, an allergic reaction is not compatible with the clinical picture and the temporal course of the manifestations observed.

On account of the ingredients and their concentrations, the physicochemical properties of the product having a pH of 11, the latency period of three days until appearance of the symptoms, the localization on the back of the hand as well as the surgical findings of intact connective and muscle tissue which is uncommon in cases of colliquative necrosis caused by alkalies, it can be stated that it is impossible to establish any association between the symptoms experienced and the use of the incriminated household cleaner. The damage must have been caused by a different toxicant such as a strong acid. Another possibility is suggested by the external findings: A severe burn or scald may have occurred by mistaking the hot water tap for the cold one, or due to a neutralization reaction produced by a strong acid. There was a strikingly severe involvement of the bone leading to the development of necrosis in this case.

As a result of discussions with experts from Poison Control Centres and occupational medicine, hydrofluoric acid was uniformly suspected to have been involved as a toxic agent. It is the only agent known to cause typical bone necrosis. Due to its low dissociation and high lipid solubility, hydrofluoric acid has a strong ability to deeply penetrate into the tissue and is readily and well absorbed. This may result in severe local damage with the corrosive action continuing for hours or days and reaching deep layers of the tissue and bones. On the skin, painful inflammations and chemical burns will develop already at low acid concentrations of 0.1 to 0.3 %. At higher concentrations of up to 20 %, pain and erythema may still develop after 24 hours or even later. In most cases, exposure to concentrations of 20 to 50 % will result in recognizable burns within one to eight hours while concentrations above 50 % will lead to a rapid onset of pain associated with visible cell destruction. Manifestations may persist for several days. In the further course, erythema, blistering, oedema, whitish to grey-black discoloration of the skin, poorly healing ulcerations and progressive necrosis in deep tissues, sometimes associated with osteolysis, may develop. Such description of manifestations could be compatible with those experienced by the patient. It remains unclear how exposure occurred. In spite of intensive questioning, the patient denied having handled any other toxic agents. Evidence for establishing an unequivocal diagnosis could have been provided by analysis of the tissue specimens retained, such as skin or fingernails, for the presence of fluoride. However, appropriate detection methods are not available at present.

Evaluation of the case described
Taking into account the chemical ingredients of the product, the symptoms and the latency period until the onset of complaints, a causal relationship with the use of the household cleaner mentioned cannot be assumed to have been present.

3.3.5 Severe inhalation poisoning resulting in pulmonary oedema after exposure to shoe impregnation spray

In an indoor environment, a 26-year-old patient had applied generous amounts of a wet blocker spray to waterproof his shoes in the evening. About 30 min later, he experienced shortness of breath, complained of breath-related thoracic pain and developed fever. For this reason, he sought assistance at the emergency ward of a hospital.

Manifestations/course
Findings made on admission, three hours after the incident, included a decrease in oxygen saturation to 80 %, an elevated body temperature of 39.4 as well as cough, dyspnoea, thoracic pain and tachycardia of 120/min. X-ray examination revealed the presence of an interstitial pulmonary oedema.

After consultation of a Poison Control Centre, the patient was given oxygen supply, antipyretic agents and fluid infusion. After initial administration of beclomethasone by inhalation, the patient was administered i.v. prednisolone. He was subjected to monitoring at the intensive care unit. In the further course, laboratory examinations revealed an increase in inflammatory parameters associated with an increase in CRP and leukocytosis so that administration of antibiotics was considered. On the next morning, prior to administration of the first dose, the patient left the hospital on his own responsibility, contrary to medical advice. Oxygen saturation on discharge of the patient was 98 %.

Notes
Impregnating agents are used in the household to restore the water and dirt repelling properties of textiles and leather products and for sanitary installations to act as a sealing coat for surfaces. The agent is available in

Fig. 16: Shoe impregnation spray

liquid form as a pump spray or for reasons of convenience, aerosol cans, to achieve a more uniform distribution. Such sprays are sold in pressure-tight cans containing the impregnating agent consisting of propellants, solvents and the active substance. Propellants used include propane, butane, and air. Typical solvents used include petrol or short-chain alcohols, and in a few products, xylene. Active substances used include silicones (polysiloxanes), fluorocarbon and melamine resins, beeswax or wool fat. The impregnating liquid has a low toxicity. Also in the form of pump sprays, impregnating or sealant sprays have been considered as safe in terms of health. In contrast, problems have been associated with aerosol sprays. The use of sprays in small and insufficiently ventilated rooms may result in conjunctival irritation, dyspnoea or in rare cases, anaesthesia-like manifestations due to the solvents contained. The causes of these manifestations have not yet been finally elucidated. Based on systematic animal studies in birds, a key role has been attributed to fluorocarbon resins and/or reactive polysiloxanes in combination with solvents. In addition, improper use such as spraying for extended periods or failure to shake the contents sufficiently etc. should also be taken into account. However, it is mainly the physical properties such as the droplet size of the sprays that decide on whether and which toxic effects are produced in the respiratory tract.

In Germany, attention was directed to the pulmonary toxicity of impregnation sprays already in 1981. Because of their inherent health risk, several sprays for the impregnation of leather were withdrawn from the market. In addition, numerous modifications of the respective formulations by the manufacturers contributed to a reduction in the number of cases of poisoning showing relevant manifestations. In 2002, another rise was recorded in the number of reports concerning impaired respiratory functions associated with impregnation sprays for leather and textiles in the Netherlands and in Switzerland.

The most recent series of cases involving sealing sprays was reported in the spring of 2006. Within a short period of time, Poison Control Centres in the German federal states reported a great number of cases with severe health disorders. Persons affected complained of cough and shortness of breath and in several cases, developed pulmonary oedema. Obviously, the persons affected had inhaled components of the atomized sprays that had remained in the indoor air as fine aerosols. Due to the small droplet size, these components may have reached the alveolar region causing an accumulation of fluid, which resulted in an impairment of the oxygen and moisture exchange, respectively. The small droplet size is only achieved if the liquid applied contains a propellant and is applied by means of a nozzle in the spray head. If, in contrast, the same liquid is applied by means of a pump mechanism, the droplet size is at least 100 micrometres and therefore, droplets cannot penetrate into the alveolar tissue. This is probably the reason why products applied to surfaces by means of pump spray bottles have not caused any problems so far. Hence, toxic effects may only occur if the substance mixture of the formulation is inhaled deeply into the lungs as a fine spray characterized by a correspondingly small droplet size.

Patients developing symptoms are provided with a fresh air supply as a first measure. There

should be an early inhalation therapy using topical steroids, and the patient should present to a hospital to exclude a presence of lung infiltrates. Onward therapy will be oriented by the symptoms.

Concerning the health risks due to impregnation sprays, a number of research projects are under way at the BfR which also include a review of case series reported in the past. In the context of the review of the case series reported in 2006, the BfR has already become aware of health impairments caused by impregnation sprays of the manufacturer of the product involved in the case described above. However, the concrete components of the formulation could only be identified during a discussion with the manufacturer in November 2008. The problem of impregnation sprays will also be considered by the BfR Committee for the Assessment of Poisonings (Kommission "Bewertung von Vergiftungen"), which has recently been re-appointed.

Evaluation of the case described
Based on the information given on the temporal relationship between exposure and the occurrence of the manifestations, and in the absence of other causes, a causal relationship has been rated as probable.

3.3.6 Death of an elderly female due to aspiration of a dishwashing detergent and gastric contents

An 80-year-old patient had accidentally ingested an unknown quantity of a manual dishwashing detergent containing surfactants. Due to its orange colour and the picture of oranges shown on the label, she probably had mistaken the detergent for a food, most probably orange juice. On the next morning, her husband found her dead in her bed. There were no indications of a suicide risk in her history. The patient had been suffering from senile dementia.

Course
At post-mortem, a dark grey-brown liquid and foaming contents were found in the stomach and small intestine. There was also a considerable digestion of parts of the mucous membrane of airways and of lung tissue, particularly that of the right lower lobe. In the contents of the stomach, of the small intestine and in the fluid dripping from the right lung lobe, anionic surfactants being components of the dishwashing detergent could be detected by chemical-toxicological analysis. According to the forensic physicians, an aspiration of gastric contents containing the dishwashing detergent ingested had been the cause of death. The formation of foam from the surfactant ingested had presumably caused vomiting which led to the aspiration of gastric contents containing the dishwashing detergent.

Notes
Anionic and non-ionic surfactants are rather safe in terms of health. In addition to the irritating effect on mucous membranes, foam formation is the predominant problem. Manifestations may include vomiting, abdominal pain, flatulence and diarrhoea. In rare cases, vomiting or formation of considerable amounts of foam in the mouth involve an aspiration risk. Aspiration may have taken place in cases where persistent cough and breathing disorders are observed. While for healthy children and adults, products containing surfactants such as shower gels, bubble baths, shampoos, all-purpose cleans-

Fig. 17: Dishwashing detergent involving the risk of being mistaken for juice

ers or liquid detergents do not pose a particular risk, they may be life-threatening or even fatal for elderly persons. They are more prone to foam aspiration after vomiting, which may result in severe pulmonary manifestations and a fatal outcome. Since 1990, a total of 23 cases have come to the knowledge of the BfR where the ingestion of major amounts of household cleansers and disinfectants resulted in severe manifestations of poisoning. 17 of these cases had a fatal outcome, which emphasizes the importance of this problem for elderly persons. All of these cases referred to disoriented elderly persons. There has certainly been a number of undetected and unreported cases.

On account of a considerable number of accidents involving household products and disinfectants, which include products containing surfactants, an expert hearing of representatives of nursing and consumers' associations, of the industries involved and the Poison Control Centres had been conducted by the BfR predecessor institute, BgVV (Federal Institute for Health Protection of Consumers and Veterinary Medicine) already in 2001. It had been the aim of this hearing to draw attention to the background of such accidents and to develop strategies for their prevention. Therefore, the annual report (Cases of Poisoning Reported by Physicians in 2001) published by the BgVV placed special emphasis on the problem of accidental ingestion by elderly and disoriented persons. In parallel, a corresponding press release was issued (BgVV-Pressedienst 11/2002), and 12 000 information leaflets in several languages were distributed to hospitals and chronic care institutions. In 2005 and 2006, the BfR was again informed about deaths of elderly persons in which products containing surfactants had been involved. Therefore, the issue was taken up again in the annual report, Cases of Poisoning Reported by Physicians in 2006, and recommendations were given such as visits to the homes of elderly persons or the use of special dispensers for detergents and cleansers. At the International Congress of the EAPCCT in Athens in 2007, the BfR presented a poster to an international audience and pointed out 23 severe cases of poisoning in elderly persons by products containing surfactants.

The risk of mistaking consumer goods for foods resulting from their misleading appearance has recently been identified by the BfR in two cases of poisoning by another product. With a packaging resembling a beverage bottle and the orange colour of the liquid, the incriminated product also simulated orange juice, and in addition, the word "orange" appeared in the product name. The product was accidentally ingested by an elderly person and a child. Both cases required outpatient treatment.

The risk of mistaking household products for foods because of their appearance is considered as a serious and possibly even increasing problem by the BfR. Therefore, the BfR Committee for the Assessment of Poisonings (Kommission "Bewertung von Vergiftungen"), which has recently been appointed, was asked to give priority to this problem in order to develop preventive approaches together with the BfR.

Evaluation of the case described
Based on the information given on the temporal relationship between exposure and death and the detection of surfactants in the contents of the patient's stomach, the small intestine and the dripping fluid of the right lung lobe, a causal relationship of the death with the dishwashing detergent has been rated as confirmed.

3.3.7 Fatal hepatic failure associated with the consumption of green-lipped mussel concentrate

A 42-year-old patient who had been suffering from gonarthrosis had taken a food supplement containing natural marine lipid complexes for about five months to reduce her

pain. The intake dose has remained unknown. Because of unspecific gastrointestinal colicky complaints and for diagnostic work-up of icterus, the patient sought medical assistance and was admitted to a hospital specialized in gastroenterology. During inpatient treatment, she developed subacute hepatic failure. Within one month when she stayed in hospital, the patient's condition showed a fulminant deterioration, and eventually, she died from multiple organ failure.

Manifestations and course
The 42-year-old patient suffering from colicky abdominal pain and icterus was admitted to hospital for diagnostic work-up. In the further course, she developed subacute hepatic failure. Clinical chemistry revealed an initial increase in cholestatic parameters (bilirubin), hepatic damage (elevated gamma GT, GOT, GPT) and a blood coagulation disorder. Imaging examinations (sonography, MRI) showed a normal size of the liver and normal liver vessels. However, the liver was found to be clearly granular and hyperechogenic, showing extensive areas of reduced perfusion suggesting necrosis. According to the imaging results, ascites was detected in all four quadrants. Histological examinations revealed the presence of parenchymal necrosis, a chronic granular inflammation and incipient cicatricial fibrosis. Histomorphological findings excluded hepatic cirrhosis, granular inflammations, cholangitis. malignancy and viral hepatitis, and a tentative diagnosis of subacute hepatic failure resulting from medicinal products was made.

The patient was initially asymptomatic during her stay at the hospital. A therapy with prednisolone was attempted. After transfer of the patient to another hospital near her place of residence in order to evaluate the chance of a liver transplantation, her condition deteriorated rapidly. She was transferred to an intensive care unit. The measures of treatment taken included dialysis, volume therapy and respiration. After hepatectomy had been performed as a measure of last resort and a portocaval shunt had been implanted, the patient's circulatory situation initially improved markedly. In the further course, however, the patient's condition again deteriorated rapidly within 24 hours. Resuscitation efforts unfortunately remained unsuccessful. The patient died in spite of maximal intensive treatment, with no opportunity to perform liver transplantation.

Notes
The food supplement containing natural marine lipid complexes is recommended by the manufacturer as an agent with anti-inflammatory and thus, analgesic activity for treating osteoarthritis, rheumatoid arthritis and asthma. It is claimed to inhibit leukotriene synthesis. According to information given by the manufacturer, the anti-inflammatory action was demonstrated in vivo for artificially induced polyarthritis in rats. Only a few studies have been available that lack comparability and have been discredited on the international level. Recent studies are said to have evaluated as more effective the preparation consisting of stabilized green-lipped mussel extract obtained by means of a modern, patented method for protecting the non- polar lipids.

The greenshell or green-lipped mussel (*Perna canaliculus*) is produced in New Zealand aquaculture farms and is regarded as a delicacy all over the world. About 10 % of the yield undergoes freeze-drying for pharmaceutical purposes. Worldwide, there is only one manufacturer of stabilized green-lipped mussel powder. According to information provided by the manufacturer, other green-lipped mussel concentrates are assumed to have similar effects, but to be 125 times less effective.

In clinical studies, this food supplement has shown no or only single adverse effects. There were only weak and, as compared to placebo, insignificant adverse effects such as skin irritation and metallic taste. Brevetoxin, a toxic metabolic product of red algae, has been detected in the hepatopancreas of green-lipped mussels. There are no studies available on the occurrence of brevetoxin in green-lipped mussel preparations. So far, evaluation of the safety in terms of health of green-lipped mussel preparations has been insufficient. Further studies are required.

In the case described above, it was assumed by the attending physicians that the subacute liver failure was most probably to be attributed to a toxic damage resulting from medicinal products. No other cause of the liver damage could be identified by means of the common (differential) diagnostic methods. There were no indications of other hepatotoxic agents such as amatoxins of the death cap, paracetamol or halogenated hydrocarbons in the patient's history.

Meanwhile, the BfR has been informed about two other, mild cases of poisoning after consumption of green-lipped mussel concentrate that might be compared with the case described above as to the cause of poisoning. Thus, a 67-year-old male developed headache, visual and memory disturbances after the regular intake of green-lipped mussel concentrate that disappeared after he had stopped taking the preparation. A 64-year-old female patient was diagnosed with toxic hepatitis resulting from medicinal products that became manifest after she had taken a green-lipped mussel concentrate for about one month. In the latter case, however, alcohol abuse played a causal role. Sonography revealed the clinical picture of hepatic cirrhosis. Mobilization of ascites by means of administration of spironolactone and a loop diuretic was successful. The further clinical course is unknown.

In analogy to patients suffering from fish poisoning due to ciguatera toxin, which is produced by phytoplankton, the clinical manifestations in the 64-year-old patient could have re-appeared or been amplified after alcohol consumption.

Evaluation of the case described
Based on the information given on the temporal relationship between the consumption of the preparation and the appearance of hepatic damage, and taking into account the two other cases associated with green-lipped mussel extracts (also with hepatic involvement) reported to the BfR, and in the absence of other causes, a causal relationship has been rated as possible.

4 Annex

4.1 Spectrum of cases reported during the period 1 January – 31 December 2008

Table 13: 56 414 reports vs. degree of severity of health disturbance, classified by children and adults, with the adult cases differentiated by exposure in the private sphere and the working environment (except for cases with a causal relationship rated as "absent")

Incriminated products/uses	Reports, total numbers					Health impairment moderate/severe				
First level Second level Third level	*Total*	*Chil-dren*	*A-dults*	*Home*	*Work*	*Total*	*Chil-dren*	*A-dults*	*Home*	*Work*
Agrochemicals *(other than pesticides)*	220	6				32		32	1	30
Fertilizers	116	6	110	6	103	12		12	1	11
Plant care products	4		4		3	2		2		1
Growth regulators	12		12		12	3		3		3
Medicinal products	2 795	739	2 036	703	1 096	480	118	359	226	41
Medical devices	353	2	351	5	346	9	1	8	1	7
Chemical products	30 175	1 649	28 501	815	27 611	2 803	452	2 344	289	2 036
Wastes, solid	284		284		284	32		32		32
Waste gases	2 662	37	2 623	94	2 520	174	8	165	27	134
Sewage	125		125		125	10		10		10
Paints and related materials	2 204	56	2 146	86	2 051	176	12	163	25	135
Paint removers/ strippers	133		133	4	129	16		16	2	14
Alkyd resin paints	3		3	1	1	2		2		1
Emulsion paints	21		21		21	4		4		4
Artist's painting materials	2	1	1		1					
Glossy paints	452	2	450	16	434	38	1	37	3	34
Parquetry sealers	33	4	29	21	8	3		3	1	2
Pigments	7		7		7	2		2		2
Primers	134		134	7	127	13		13	4	9
Paint thinners	872	42	830	16	807	51	9	42	4	37
Fire lighting products	110	93	16	12	4	45	36	9	7	2
Building materials, auxiliary products	343	8	335	9	326	38	2	36	5	31
Building materials	1 613	2	1 608	17	1 591	216	1	213	1	212
Fuels, solid	2		2		2					
Fuels, solid; auxiliary products	7		7		7					
Fuels, liquid	1 156	750	400	29	363	363	315	47	21	25

Incriminated products/uses	Reports, total numbers					Health impairment moderate/severe				
First level Second level Third level	*Total*	*Chil-dren*	*A-dults*	*Home*	*Work*	*Total*	*Chil-dren*	*A-dults*	*Home*	*Work*
Petrol	233	16	217	3	212	18	3	15	1	13
Ethanol for technical use	61	5	56	5	49	5		5	4	1
Lamp oil	745	724	15	13	1	321	309	11	11	
Fuels, auxiliary products; liquid	4		4		4					
Fuels, gaseous	40		40	3	36	8		8	2	6
Office materials, chemical	179	5	174	2	169	41	1	40	0	40
Decoration materials	21	5	16	6	10	4	2	2	2	0
Dental materials	135	1	134	21	111	20		20	9	10
Disinfectants/ sterilizers	3 165	14	3 151	31	3 117	155	1	154	15	139
Deodorants for technical use	90	63	27	5	22	4	3	1	1	
Diagnostic agents/ reagents	30	1	29		29					
Printing, auxiliary products	32		32		32	2		2		2
Insulating materials for electric equipment	2		1		1					
De-icing products	15		15	1	14	1		1		1
Fire extinguishing media	177	1	176	3	172	9		9		9
Flame retardants	3	1	2		2	1	1			
Photochemicals	94		94	2	92	1		1	1	
Galvanic cells	992	12	980	2	976	47	1	46		46
Accumulators	947	1	946	1	943	45		45		45
Dry cells	35	2	33		33	2		2		2
Button batteries	10	9	1	1		1	1			
Galvanizing agents, auxiliary products	27	1	26		26	8	1	7		7
Galvanizing agents	24		24	1	22	4		4	1	2
Gases for technical use	22		22		22	2		2		2
Antifreezes	40	4	36	11	24	10		10	7	2
Foundry auxiliary products	1		1		1					
Glass-working, auxiliary products	5		5		5	2		2		2

Incriminated products/uses	Reports, total numbers					Health impairment moderate/severe				
First level Second level Third level	*Total*	*Chil-dren*	*A-dults*	*Home*	*Work*	*Total*	*Chil-dren*	*A-dults*	*Home*	*Work*
Glass-making, auxiliary products	1		1		1					
Rubber, production materials	21	1	20		20	1		1		1
Semiconductors, production materials	6		6		6					
Household auxiliary products, chemical-technical	5	2	3	2	1	2	1	1	1	
Hydraulic fluids	337	3	333		333	13		13		13
Ceramics, auxiliary products	13	1	12	2	10	2		2	1	1
Ceramic materials	4		4		4					
Glues	996	26	970	28	940	79	7	72	7	65
Plastics, starting materials	225	38	187	3	184	25		25	2	23
Plastics, formulating materials	22		22		22	3		3		3
Refrigerants	69		69	1	68	7		7	1	6
Coolants	215	20	195	2	193	14		14	1	13
Leather processing products	9	1	8	3	5	4	1	3	2	1
Luminophors	13		13	1	12					
Solvents for technical use	880	7	873	39	830	90	1	89	10	78
Soldering and welding products *(except welding fumes)*	95	4	91		91	8	3	5		5
Metal repair auxiliary products	1		1		1					
Metallurgy, auxiliary products	200		200	2	198	26		26	2	24
Measuring equipment, chemical-technical	30	9	20	8	11	1		1	1	
Heating meters	15	6	8	7	1	1		1	1	
Mercury thermometers	6	3	3	1	2					
Thermometer fluids	7		7		6					

Incriminated products/uses	Reports, total numbers					Health impairment moderate/severe				
First level Second level Third level	*Total*	*Chil-dren*	*A-dults*	*Home*	*Work*	*Total*	*Chil-dren*	*A-dults*	*Home*	*Work*
Microbiological auxiliary products	1		1		1					
Dairy, auxiliary products	1	1								
Paper-making, auxiliary products	13		13		13	2		2		2
Radioisotopes, radionuclides	6		6		6					
Cleaning products	9 025	393	8 626	325	8 278	857	51	804	118	679
Drain cleaners	189	39	149	15	133	56	18	38	10	28
All-purpose cleaners	603	31	571	17	551	38		37	9	28
Oven and grill cleaners	321	15	306	3	303	35	5	30	2	28
Cleansers for electronic products	5	2	3		3	1		1		1
Descaling products	298	24	273	20	253	18	1	17	5	12
Front wall and stone cleaners	63		63	5	58	14		14	3	11
Stain removers	32	16	16	1	15	3	1	2		2
Floor polishes	57	6	51	6	45	5		5	1	4
Washing-up detergents (manual use)	124	33	91	11	79	13	1	12	7	5
Dishwasher detergents	184	33	151	6	144	19	3	16	3	13
Dishwasher cleaners	81		81		81	7		7		7
Glass cleaners	148	9	139	93	46	26	1	25	23	2
Industrial cleaners	690	5	685	5	678	69	3	66	3	62
Rinsing additive for dishwashers	75	9	66		66	4		4		4
Plastic cleaners	28	3	25		25					
Glossy paint cleaners	5		5		5					
Milking machine cleaners	509	11	498	1	497	63	6	57		57
Metal cleaners	237	8	229	3	225	21	1	20	2	18
Furniture polishes	24	18	6	4	2	3	2	1	1	
Soot remover	7	2	5		5	2		2		2
Lavatory cleansers	408	41	367	71	290	41	1	40	23	14

Incriminated products/uses	Reports, total numbers					Health impairment moderate/severe				
First level Second level Third level	*Total*	*Chil-dren*	*A-dults*	*Home*	*Work*	*Total*	*Chil-dren*	*A-dults*	*Home*	*Work*
Shoe and leather cleaners	43	6	36	34	1	16	1	15	15	
Shampoos (techn. use)	1		1		1	1		1		1
Carpet/upholstery cleansers	13	2	11	3	8	4	1	3	2	1
Detergents, auxiliary products	41	16	25	7	17	5		5	1	4
Detergents	141	28	113	10	103	13		13	5	8
Joke articles	4	3	1		1					
Lubricants	269	4	265	1	264	12		12	1	11
Welding fumes	320		320	3	315	33		33	1	30
Toys	13	9	4	2	2	3	3			
Dust-laying oils	2		2		2					
Textile, auxiliary products	32	3	29	11	18	12		12	7	5
Propellants/sprays	14		14		14	1		1		1
Washing-active raw materials	2		2		2					
Water treatment products	48	3	45		45	2		2		2
Pet shop products	7	2	5		5					
Narcotic drugs	50	1	46	35	2	26		26	20	
Primary substances	16 317	331	15 858	362	15 373	2 037	56	1 980	133	1 812
Cosmetics and personal hygiene products	819	109	705	205	497	101	10	91	65	26
Hair care products	248	29	219	42	176	28	4	24	17	7
Permanent wave products	48	4	44	1	43	3		3	1	2
Depilatory products	18	2	16	15	1	2		2	2	
Hair conditioners	30	2	28	6	22	3		3	3	
Hair dyes / colorants	109	5	104	11	92	14	3	11	8	3
Hair tonics	2		2	2		1		1	1	
Shampoos	29	15	14	4	10	2		2	1	1
Skin care products	440	62	373	108	265	48	5	43	27	16
Bath oils / salts	39	11	28	10	18	8		8	6	2
Tanning products	2		2	2						
Cremes, ointments and lotions	102	15	83	61	22	15		15	12	3

Incriminated products/uses	Reports, total numbers					Health impairment moderate/severe				
First level Second level Third level	*Total*	*Chil-dren*	*A-dults*	*Home*	*Work*	*Total*	*Chil-dren*	*A-dults*	*Home*	*Work*
Deodorants	16	1	15	2	13	2	1	1	1	
Face tonics	1	1								
Make-up products	8	2	6	2	4	1	1			
Perfumes, after shaves	43	17	26	2	24	4	1	3	1	2
Powders	3	1	2	1	1					
Soaps	173	5	168	6	162	10		10	2	8
Sun blockers	9	3	5	5		3	2	1	1	
Oils	12	3	9	3	6	2		2	2	
Oral care and dental products	67	3	64	39	25	16		16	15	1
Nail care products	54	16	38	12	24	7	1	6	5	1
Pesticides	2 665	191	2 467	644	1 727	669	27	639	311	299
Acaricides	5		5		5	1		1		1
Fungicides	166	6	158	10	144	39	1	38	4	32
Herbicides	375	11	364	26	328	63	1	62	12	46
Wood preservatives	306	26	280	178	96	133	8	125	85	35
Insecticides	1 218	108	1 106	407	629	356	15	339	207	115
Carbamates	52	5	47	15	30	16	1	15	7	7
Phosphoric esters	356	19	335	139	179	156	1	155	112	32
Pyrethroids	410	48	362	128	233	90	3	87	49	37
Chlorinated hydrocarbons	253	28	223	125	51	79	10	67	39	24
Molluscicides	11	5	5		5	1				
Repellents	12	4	8	5	3	2		2	1	1
Rodenticides	91	32	59	19	38	12	2	10	10	
Anticoagulants	33	18	15	7	6	4		4	4	
Phosphates	33	5	28	10	18	8	2	6	6	
Seed dressings	20	2	18		17	5		5		5
Plants	237	141	95	48	46	33	4	29	19	10
Fungi	74	25	48	39	9	29	5	24	23	1
Others	1 289	30	1 255	110	1 139	151	11	139	34	102
Textiles	430	8	421	77	344	58	5	52	22	30
Clothing	343	2	340	12	328	32	2	29	4	25
Furnishing fabrics	71	5	66	60	6	24	3	21	18	3
Foods and beverages	1 003	157	815	472	315	214	24	187	148	25
Alcoholic beverages	175	13	159	75	63	52	7	45	31	3
Food additives	37	2	35	1	34	5		5		5
Food supplements	199	10	183	180	3	43	3	38	38	

Incriminated products/uses	Reports, total numbers					Health impairment moderate/severe				
First level Second level Third level	*Total*	*Chil-dren*	*A-dults*	*Home*	*Work*	*Total*	*Chil-dren*	*A-dults*	*Home*	*Work*
Tobacco and tobacco products	142	103	38	27	2	29	3	26	21	
Industrial accidents	2 093	213	1 871	466	1 303	223	10	213	47	163
Veterinary medicinal products	105	14	85	32	52	24	5	17	13	4
Animals	27	3	23	7	16	9	1	8	4	4
Warfare/anti-riot agents	100	14	85	10	74	5	1	4		4
Pyrotechnic products	5	2	3		3	1		1		1
Tear gas	59	9	49	8	40	3	1	2		2

4.2 Reporting form for cases of poisoning

Bundesinstitut für Risikobewertung
Dokumentations- und Bewertungsstelle
für Vergiftungen
Postfach 33 00 13

14191 Berlin

Stempel, Telefon-Nummer und Unterschrift der/des Ärztin/Arztes

Mitteilung bei Vergiftungen
nach § 16e Abs. 2 des Chemikaliengesetzes
Telefon: 030 18412-3460, Fax: 030 18412-3929, E-Mail: giftdok@bfr.bund.de

1. Angaben zur/zum Patientin/en:

Alter: Jahre ☐ Monate (bei Kindern unter 3 Jahren) ☐

☐ männlich ☐ weiblich

Schwangerschaft (**freiwillig** auszufüllen) ☐ ja ☐ nein

2. Vergiftung ☐ **Verdacht** ☐

Unbedingt Handelsname der Zubereitung/des Biozid-Produktes oder Stoffname, aufgenommene Menge und Hersteller (Vertreiber); ggf. vermutete Ursache

a.

b.

c.

3. Exposition ☐ akut ☐ chronisch ☐ oral ☐ inhalativ ☐ Haut ☐ Auge sonstiges, welche ☐

Art der Vergiftung:	☐ akzidentell (Unfall)	☐ gewerblich	☐ Verwechslung	
	☐ suizidale Handlung	☐ Abusus	☐ Umwelt	☐ Sonstiges
Ort:	☐ Arbeitsplatz	☐ im Haus	☐ Schule	
	☐ Kindergarten	☐ im Freien	☐ Sonstiges	
Labor-Nachweis:	☐ ja	☐ nein		
Behandlung:	☐ keine	☐ ambulant	☐ stationär	
Verlauf:	☐ nicht bekannt	☐ vollständige Heilung	☐ Defektheilung	☐ Tod
	☐ Spätschäden (nicht auszuschließen)			

(**freiwillig** auszufüllen)

4. Symptome, Verlauf – stichwortartig – (ggf. anonymisierte Befunde, Epikrise beilegen)

4.3 Reporting form for industrial accidents

BfR-Fragebogen zur Expositionsermittlung bei Stör- und Transportunfällen

Pers. Nummer

weiblich ☐ männliich ☐ Erwachsene(r) ☐ Kind ☐

Bereich I

Unmittelbar Betroffene(r)

(Bitte Eintrag in die Landkarte)

Direkt am Unfallort ☐
Nahe Unfallort ☐
☐ m

Arbeiter(in) ☐
Feuerwehr ☐
Polizei/Rettungsdienst ☐
Privatperson ☐
Sonstige(r) ☐

Erstexposition Uhrzeit ☐ Datum ☐
Dauer ständig ☐ nicht ständig Stunden/Tage ☐
Schutzmaßnahmen ja ☐ nein ☐
Symptome ja ☐ nein ☐
(Wenn ja, bitte Dokumentation auf dem Meldebogen)

Bereich II

Nicht unmittelbar Betroffene(r)

(Bitte Eintrag in die Landkarte)

Entfernung vom Unfallort
☐ m
☐ km

Anwohner ☐
Beschäftigte(r)/Arbeitnehmer(in) ☐
Sonstige(r) ☐ ☐

Erstexposition Uhrzeit ☐ Datum ☐
Dauer ständig ☐ nicht ständig Stunden/Tage ☐
Symptome ja ☐ nein ☐
(Wenn ja, bitte Dokumentation auf dem Meldebogen)

Biomonitoring **Stoff:** ☐

Blutentnahme ☐ Datum ☐ Zeitpunkt ☐ Konzentration ☐
Urinprobe ☐ Datum ☐ Zeitpunkt ☐ Konzentration ☐
Spontanurin ☐ 24h Sammelurin ☐ Kreatinin ☐

4.4 List of Poison Control Centres in Germany (status as of September 2009)

Berlin	BBGes – Giftnotruf Berlin Inst. f. Toxikologie Klinische Toxikologie und Giftnotruf Berlin	Oranienburger Straße 285	13437 Berlin	Phone: +49 (0) 30/1 92 40 Fax: +49 (0) 30/30 68 67 99 mail@giftnotruf.de www.giftnotruf.de
Bonn	Informationszentrale gegen Vergiftungen Zentrum für Kinderheilkunde Universitätsklinikum Bonn	Adenauerallee 119	53113 Bonn	Phone: +49 (0) 2 28/1 92 40 and +49 (0) 2 28/28 73 33 14 Fax: +49 (0) 2 28/28 73 32 78 gizbn@ukb.uni-bonn.de www.giftzentrale-bonn.de
Erfurt	Gemeinsames Giftinformationszentrum der Länder Mecklenburg-Vorpommern, Sachsen, Sachsen-Anhalt und Thüringen	Nordhäuser Str. 74	99089 Erfurt	Phone: +49 (0) 3 61/7 30 7 30 Fax: +49 (0) 3 61/7 30 7 3 17 ggiz@ggiz-erfurt.de www.ggiz-erfurt.de
Freiburg	Zentrum für Kinder- und Jugendmedizin Vergiftungs-Informations-Zentrale	Mathildenstraße 1	79106 Freiburg	Phone: +49 (0) 7 61/1 92 40 Fax: +49 (0) 7 61/2 70 44 57 giftinfo@uniklinik-freiburg.de www.giftberatung.de/
Göttingen	Giftinformationszentrum-Nord der Länder Bremen, Hamburg, Niedersachsen und Schleswig-Holstein (GIZ-Nord) Universitätsmedizin Göttingen – Georg-August-Universität	Robert-Koch-Str. 40	37075 Göttingen	Phone: +49 (0) 5 51/1 92 40 Fax: +49 (0) 5 51/3 83 18 81 giznord@giz-nord.de www.Giz-Nord.de/
Homburg	Informations- und Beratungszentrum für Vergiftungsfälle Klinik für Kinder- und Jugendmedizin Universitätsklinikum des Saarlandes	Kirrbergerstraße Gebäude 9	66421 Homburg/ Saar	Phone: +49 (0) 68 41/1 92 40 (emergency) +49 (0) 68 41/1 62 83 36 (office) Fax: +49 (0) 68 41/1 62 11 09 giftberatung@uniklinikum-saarland.de www.uniklinikum-saarland.de/giftzentrale

Mainz	Giftinformationszentrum (GIZ) der Länder Rheinland-Pfalz und Hessen Klinische Toxikologie Universitätsklinikum	Langenbeckstraße 1	55131 Mainz	Phone: +49 (0) 61 31/1 92 40 or +49 (0) 7 00-GIFTINFO Infoline: +49 (0) 61 31-23 24 66 Fax: +49 (0) 61 31/23 24 68 or +49 (0) 61 31/28 05 56 mail@giftinfo.uni-mainz.de www.giftinfo.uni-mainz.de/
Munich	Giftnotruf München Toxikologische Abteilung der II. Med. Klinik und Poliklinik, rechts der Isar der Technischen Universität München	Ismaninger Straße 22	81675 Munich	Phone: +49 (0) 89/1 92 40 tox@lrz.tu-muenchen.de www.toxinfo.org/
Nuremberg	Giftnotrufzentrale Nürnberg Med. Klinik 1, Klinikum Nürnberg Lehrstuhl Innere Medizin-Gerontologie Universität Erlangen-Nürnberg	Prof.-Ernst-Nathan-Str. 1	90419 Nuremberg	Giftnotruf: +49 (0) 9 11/3 98-24 51 Phone: +49 (0) 9 11/3 98 26 65 Fax: +49 (0) 9 11/3 98 22 05 giftnotruf@klinikum-nuernberg.de

4.5 Press releases on toxicological problems issued by the BfR in 2008

BfR does not rule out health impairments caused by emissions from office equipment
07/2008, 18 April 2008

New warnings for dangerous chemicals aim to afford consumers better protection
15/2008, 2 September 2008

How dangerous are gases from ship containers for consumers?
A BfR expert meeting is to examine the available data and identify research needs.
20/2008, 5 November 2008

To successfully treat intoxications caused by consumer products, the formulations must be known
BfR and its Committee "Assessment of Poisonings" propose new labelling for identification purposes in emergencies
25/2008, 21 November 2008

Impregnating sprays and tattoo-removing agents
BfR brochure documents intoxication cases from 2007
27/2008, 15 December 2008

New EU Toys Directive doesn't sufficiently protect children's health
BfR recommends improvements to safety and non-toxicity of toys
29/2008, 29 December 2008

4.6 Abbreviations

Abbreviation	Meaning
µg/g	Amount by mass in micrograms per gram
µg/l	Amount per volume in micrograms per litre
ADH	Alcohol dehydrogenase
ASB	Assisted spontaneous breathing
ATP	Adenosine triphosphate
BfR	Bundesinstitut für Risikobewertung – Federal Institute for Risk Assessment
BG	Berufsgenossenschaften – institutions for statutory accident insurance and prevention for trade and industry in Germany
BgVV	Bundesinstitut für gesundheitlichen Verbraucherschutz und Veterinärmedizin – Federal Institute for Health Protection of Consumers and Veterinary Medicine
BIA	Berufsgenossenschaftliches Institut für Arbeitsschutz – BG-Institute for Occupational Safety and Health
BVL	Bundesamt für Verbraucherschutz und Lebensmittelsicherheit – Federal Office of Consumer Protection and Food Safety
CEN	Comité Européen de Normalisation – European Committee for Standardization
CFC	Chlorofluorocarbons
ChemG	Chemikaliengesetz – Chemicals Act (Germany)
CK	Creatine kinase
CK-MB	Creatine kinase fraction specific for cardiac muscle
CNS	Central nervous system
COCl2	Carbonyl chloride
COHb	Carboxyhaemoglobin
CPAP	Continiuous positive airway pressure
CRP	Capsule-reactive protein
CT	Computed tomographie
DMPS	Dimercaptopropane sulfonate
DNP	Dinitrophenol
EAPCCT	European Association of Poisons Centres and Clinical Toxicologists
ECG	Electrocardiography
EEG	Electroencephalography
EN	European Standards
FDA	Food and Drug Administration
GHS	Globally Harmonized System of Classification and Labelling of Chemicals
GOT	Glutamate oxaloacetate transaminase
GPT	Glutamate pyruvate transaminase
Hb	Haemoglobin
HBM	Human Biomonitoring
HBO	Hyperbaric oxygen therapy
i. v.	Intravenous
ILA	Interventional Lung Assist
MAK value	Maximale Arbeitsplatzkonzentration – maximum admissible concentration at the workplace
mg/dl	Milligrams per decilitre

mmHg	Millimetres of mercury
mmol/l	Millimoles per litre
MRI	Magnetic resonance imaging
NO	Nitrogen monoxide
NO_2	Nitrogen dioxide
paO_2	Partial oxygen pressure in the arterial blood
PCC	Poison Control Centre
pCO_2	Partial pressure of carbon dioxide
PEEP	Positive end-expiratory pressure
pO_2	Partial oxygen pressure
ppm	parts per million
PRINS	Product information system
SH group	Sulfhydryl group, also referred to as thiol group
SpO_2	Peripheral oxygen saturation
U/l	Units per litre
WRMG	Wasch- und Reinigungsmittelgesetz – Detergents and Cleaning Agents Act (Germany)
XML file	Extensible Markup Language

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