National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport

Detecting emerging risks for workers and follow-up actions

RIVM report 601353004/2013

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Colophon

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This investigation has been performed by order and for the account of Bureau REACH, within the framework of identifying emerging risks.

Abstract

Unknown health risks for workers; Detection and follow-up measures

Despite existing laws and regulations in place to limit the risks of dangerous substances at work, new risks continue to emerge. RIVM is advocating the development of a system to identify such risks at an early stage in order to prevent more people from falling ill. Several steps have already been taken. International cooperation is important in such a system to guarantee the development of proper methods to detect new risks, to coordinate communication about new risks and to take national or international measures as soon as possible.

This was the conclusion of a study conducted by RIVM for which experts in this field were interviewed. The study includes an overview of new risks that are causing health problems. The use of the artificial butter flavouring (diacetyl) by people working in the popcorn production industry has been regulated, for example, because it can cause severe respiratory problems when it is inhaled. Diacetyl is nonetheless still used in other food sectors such as the coffee processing industry.

Causes
Relatively little seems to be known about the harmful effects of substances in the workplace. This is due to the fact that the risk assessment of most substances is based on tests in which the substance is swallowed. Workers, however, are mainly exposed to substances via the airways (inhalation) or the skin.

Added to this is the fact that many occupational physicians lack specific knowledge about the adverse work-related health effects caused by dangerous substances. Another reality is the lack of communication between the Dutch health care sector and company health services concerning possible connections between health disorders and the work environment. As a consequence, new adverse work-related effects on human health are seldom detected or are detected too late in the Netherlands. This is in some part also due to the Dutch financing system, in which there is no incentive for insurers to study the cause of an illness. Several European countries do have such incentives and new cases are reported and processed in a database.

Follow-up measures
The availability of the online contact point SIGNAAL (https://www.signaal.info/) is a move towards establishing the desired system. At the website, occupational physicians can report a possible new work-related risk. The aim is to have the risk evaluated by a group of Dutch experts consisting of occupational physicians, toxicologists, occupational hygienists and others. This group of experts still has to be founded. The next step is to communicate the evaluation to Modernet, an international network of professionals that study new risks and share knowledge with each other, with the aim of introducing measures to reduce the risk. The Netherlands was one of the initiators of Modernet. The network has existed for several years.

Key words: Workers, dangerous substances, new risks, emerging risks

Rapport in het kort

Onbekende gezondheidsrisico's voor werkers; Opsporing en vervolgacties

Ondanks bestaande wet- en regelgeving om de risico's van gevaarlijke stoffen op de werkvloer te beperken, doen zich nog altijd nieuwe risico's voor. Het RIVM pleit er daarom voor een systeem te ontwikkelen dat dergelijke risico's snel oppikt, zodat kan worden voorkomen dat meer mensen ziek worden. Inmiddels zijn daartoe enkele stappen genomen. Bij zo'n systeem is internationale samenwerking van belang om ervoor te zorgen dat de juiste methoden worden ontwikkeld om nieuwe risico's op te sporen, de communicatie over nieuwe risico's goed verloopt, en zo snel mogelijk nationale of internationaal maatregelen kunnen worden getroffen.

Dit blijkt uit een studie van het RIVM, waarvoor professionals uit het veld zijn geïnterviewd. De studie bevat ook een overzicht van nieuwe risico's die hebben geleid tot gezondheidsproblemen. Zo is het gebruik van de smaakstof boteraroma (di-acetyl) voor mensen die in bedrijven werken waar popcorn werd gemaakt, gereguleerd omdat het na inademing een zeer ernstige luchtwegaandoening kan veroorzaken. Desondanks blijkt deze smaakstof ook in andere branches, zoals de koffieverwerkende industrie, nog steeds te worden gebruikt.

Oorzaken

Er blijkt relatief weinig bekend te zijn over de schadelijke effecten van stoffen op de werkvloer. Dat komt onder andere doordat de risicobeoordeling van de meeste stoffen wordt gebaseerd op tests waarbij de stof wordt ingeslikt. Voor werkers daarentegen is het contact met een stof via de luchtwegen (inademen) of huid juist relevant.

Daarnaast ontbreekt het veel bedrijfsartsen aan specifieke kennis over arbeidsgerelateerde gezondheidseffecten van gevaarlijke stoffen. Ook communiceert de Nederlandse reguliere gezondheidszorg zelden met de bedrijfsgezondheidszorg over mogelijke verbanden tussen aandoeningen en de werkomgeving. Met als gevolg dat nieuwe gezondheidseffecten op de werkvloer in Nederland bijna niet, of te laat, worden opgepikt. Dit is mede te wijten aan het Nederlandse financieringsstelsel, waarbij verzekeraars niet worden geprikkeld om te achterhalen wat de oorzaak is van een ziekte. In enkele Europese landen is deze prikkel er wel en worden nieuwe cases gerapporteerd en in databases verwerkt.

Vervolgacties

Als aanzet tot het gewenste systeem is sinds juli 2013 het online loket SIGNAAL beschikbaar (https://www.signaal.info/), waar bedrijfsartsen een mogelijk nieuw arbeidsgerelateerd risico kunnen melden. Het streven is om vandaaruit het risico te laten evalueren door een nog op te richten Nederlandse expertgroep van bedrijfsartsen, toxicologen, arbeidshygiënisten en dergelijke. Daarna kan het worden ingebracht bij Modernet, een internationaal netwerk van professionals die nieuwe risico's onderzoeken en kennis met elkaar delen en daarmee eventuele maatregelen voeden. Nederland is een van de initiatiefnemers van Modernet, dat al enkele jaren bestaat.

Trefwoorden:
Werkers, gevaarlijke stoffen, nieuwe risico’s, opkomende risico’s

Contents

Summary

The impairment of workers' health through exposure to substances is a known problem leading to occupational disease (1.2 % in 2011 in the Netherlands) or death (1,850 deaths per year in the Netherlands). European and Dutch regulations force employers to perform a risk assessment and take actions to control exposure to such substances to prevent damage to human health. The risk assessment is based on current knowledge of hazards and exposure. In spite of the regulations, unexpected adverse effects on human health are reported regularly, as can be concluded from the chapter 'Examples of emerging risks'. This might be due to unknown hazards of the substance in question and/or a new way of using the substance. The ultimate goal of the National Institute for Public Health and the Environment (RIVM) is to identify and evaluate emerging risks as soon as possible so that measures can be taken to prevent further damage to health. The aim of this report is to provide evidence that emerging risks are still a problem by (a) giving an overview of emerging risks, (b) identifying problems in the Dutch health care structure and (c) identifying gaps within (inter)national legislation. Towards this end, a structure is being proposed to identify and evaluate emerging risks to meet the ultimate goal. International cooperation is essential to this effort. The focus of this report is on detecting emerging risks for workers. In two separate reports, emerging risks for consumers and the environment will be addressed as well.

The identification of emerging risks requires several complementary methods to be used. In the case of a rare disease with a strong aetiological relationship between work and the health complaints, a clinical watch system is more suitable than epidemiological research. Epidemiological research conducted among large groups of employees is more appropriate when adverse effects on health frequently arise with a low aetiological relationship. Health surveillance can also be used as an early warning system for the unknown effects of exposures. This report contains an overview of (inter)national organizations engaged in detecting and analysing emerging risks. An overview of (possible) emerging risks of substances that were gathered from these organizations is subsequently presented.

Identifying emerging risks is problematic in the Netherlands because there is almost no incentive to study the causality between occupation – exposure – health effect. Besides, there is a lack of knowledge among professionals on substance-related health effects and there is a lack of communication between occupational physicians, general practitioners and medical specialists. Recently, the Netherlands Centre for Occupational Disease (NCOD) launched an e-tool (SIGNAAL) where physicians can report emerging risks. These signals will be evaluated by experts of the NCOD and discussed in MODERNET, an international network of experts engaged in identifying emerging risks for workers.

Substances that turn out to be possible emerging risks ought to be further regulated. The combination of worker safety legislation and REACH/CLP or product-specific legislation should assure the safety of workers and the sharing of vital information. Nevertheless and despite all measures, there may still be information gaps and procedural pitfalls that prevent the identification of emerging risks.

This report contains an overview of some of the pitfalls in the REACH legislation, e.g. the fact that REACH focuses on high volumes and hazardous chemicals, which means that many substances are not within the scope of REACH or that worker exposure is not estimated. Identification of a substance as a SVHC (substance of very high concern) may be an interesting possibility to further regulate a substance within REACH. To identify a substance as a SVHC, it may be necessary to generate additional information, which may be provided by the substance evaluation process within REACH. This additional information may also lead to a change in the classification and labelling of a substance, which may have an effect on the REACH requirements and/or the requirements coming from worker safety legislation.

The identification of emerging risks requires continuous action, comprising the collection of case reports and literature searches followed by analysis by a group of experts. Therefore, the recommendation is to:

- further promote SIGNAAL among physicians and give access to this e-tool to other professionals and possibly workers;
- perform periodic literature searches, both of published literature and websites, to update the overview of emerging risks presented in this study;
- work together within MODERNET to gain access to information that is gathered from the analysis of databases containing information on occupation, exposure and health effects from possible emerging risks;
- create a national group of experts comprising occupational physicians, medical specialists, epidemiologists and occupational hygienists to evaluate the causality of possible emerging risks;
- discuss possible emerging risks within the MODERNET network to guarantee European uniformity in the evaluation and communication of emerging risks;
- disseminate knowledge and information about emerging risks by using national and international organisations and networks to inform professionals, manufacturers/importers/users of the substance, the labour inspectorate and other stakeholders in the field as soon as possible so that actions can be taken to prevent further damage to human health;
- consult Bureau REACH of RIVM to check how a chemical is regulated and enforced. Depending on the situation, action can be taken through increased enforcement in cases involving non-compliance with the regulations, through the re-evaluation of the occupational exposure limit and/or the derived no-effect level in cases involving health effects below these values, through the generation of additional information and through further regulation on the substance using the REACH processes or other legal frameworks.

1 Introduction

One of the basic conditions for working with chemicals is the provision that the risk from hazardous chemicals to the safety and health of workers is addressed. For this purpose both national legislation and international legislation was developed. According to the European Chemical Agent Directive (CAD), which was implemented in the Dutch legislation (*Arbowet* and *Arbobesluit*), employers are obliged to perform a risk assessment for all chemicals workers are exposed to. Information on the hazard presented by a chemical must be translated into an occupational exposure limit value (OEL) and compared with the actual workers' exposure. In cases where there is (a risk of) non-compliance with the OEL, measures must be taken to reduce the exposure, followed by a re-evaluation of the exposure. Based on the risk assessment, an occupational physician may decide to recommend a preventive medical examination for the workers exposed.

This strategy of performing risk assessments and preventive medical examinations is based on available knowledge of the hazards of particular chemicals; unknown hazards and risks are not taken into account. As a consequence, new risks are detected too late and preventive measures are impeded. The health effects caused by asbestos are possibly the most poignant example of a failure to react to early warnings.

The REACH legislation has been in effect since 1 July 2007. REACH stands for Registration, Evaluation, Authorization and Restriction of Chemicals. Manufacturers and importers are obliged to guarantee the safe use of chemicals for workers, consumers and the environment. Depending on the annual amount of the chemical manufactured or imported, more or less information on hazards and exposure is required. The hazard information that is gathered in REACH is mainly based on pre-described toxicity tests, though REACH also provides the opportunity to use other sources, such as read-across, waiving, QSARs, etc., to meet the information requirements. Much additional information on chemicals has been gathered since the REACH legislation came into effect. This information will finally pop up on the Material Safety Data Sheet (MSDS) on a substance, which is the information that will be accessible to the downstream user and the risk assessor to perform the risk assessment. In addition, the downstream user is obliged to report as yet unknown health effects to the players higher in the product chain. In REACH there is an obligation for the member states to report chemicals that generate health or environmental problems despite all legal and regulatory obligations. This obligation resulted in this project, which is focused on tracking down the health effects in workers that are generated by chemicals.

Although a great deal of effort goes into risk assessment in order to manage the risks brought on by new technologies, signalling new and undesirable side effects of work on health is a complementary approach. In society, the need to identify new health risks more quickly and more effectively has grown, particularly over the past decade. It is continually emphasized that identifying new risks is a process that involves many uncertainties and many actors, in which a balance must be found between a dynamic approach and a considered approach. The challenge is to prevent any occupational damage to human health without creating unnecessary concern (EC, 2013).

There is an increasing need to improve EU and national policies on preventing occupational diseases because of:

1. The continuing progress of technological development, which affects production processes and working conditions and which may give rise to new work-related risks;
2. Increased outsourcing and subcontracting that may lead to the concentration of risks in smaller companies operating in an extremely competitive market, which may lead in turn to less attention being given to a healthy work environment;
3. The difficulties of finding a relationship between exposure to a chemical and a health effect in small companies because of the small number of workers exposed, which makes it difficult for the occupational physician to correlate exposure and health effects. A complicating factor is that small companies in the Netherlands often buy marginal support from experts such as occupational physicians;
4. The contemporary situation in which workers often change jobs, which leads to complex and changing exposure situations. This complicates the discovery of exposure-related health effects. If workers are temporarily hired from countries abroad, it is even more difficult to find a relationship between (historical) exposure and health effects, since the health effects may pop up in a country other than the one where those workers were exposed to a substance;
5. Possible aggregated exposure to the same substance via different routes of exposure and/or exposure both at work and at home.

REACH provides baseline protection for human health and the environment. In addition, several national and international organizations recognize the need to identify new and increasing risks.
The most important initiatives are listed below:

- In a report by the Social and Economic Council of the Netherlands (SER) entitled 'Advisory report on the approach to and the insurability of occupational health risks" (*'Advies over de aanpak en de verzekerbaarheid van nieuwe arbeidsgerelateerde arbeidsrisico's*) it was stated that there is insufficient knowledge about possible new occupational health risks (SER, 2002);
- The European Union established the European Agency for Safety and Health at Work (EU-OSHA), which publishes Expert Forecasts. One of the Expert Forecasts deals with occupational diseases caused by dangerous substances (EU-OSHA, 2009);
- In the EU-OSHA Strategy 2009-2013, the strategic goals include the anticipation of new and increasing risks in order to facilitate preventive measures: http://osha.europa.eu/en/publications/work_programmes/strategy2009-2013;
- The MODERNET (Monitoring Occupational Disease and Emerging Risks NETwork) network was established and supported by COST (European cooperation in science and technology). One of the aims is to rapidly exchange information on possible new work-related diseases between European countries. The system is based on both the reporting of cases by physicians and the analysis of clusters of disease.

An important objective of this study is to create a methodology that identifies chemicals that cause health problems as soon as possible, so that legislation and/or rules can be adjusted or developed to handle the situation. The focus of

this study will be on detecting emerging risks for workers. This will be the first of three reports on identifying emerging risks. Reports on consumers (health) and the environment will follow.

The methods used to identify emerging risks depend on the protection group, but they show a similarity in the sequence of substance(s) that may have an effect on the protection group, which must be picked up and evaluated before action can be taken.

In Chapter 2, definitions will be given for 'occupational disease' and 'emerging, new and increasing risks'. Methods to identify emerging risks, including their benefits and drawbacks, will be discussed in Chapter 3. Chapter 4 describes organizations that analyse emerging risks, including an overview of websites. The situation in the Netherlands regarding the identification of emerging risks is presented in Chapter 5, including problems related to the Dutch system. Chapter 6 discusses the relationship between emerging risks and national and international legislation, including discrepancies in the legislation with respect to emerging risks. In Chapter 7, examples of chemicals that cause emerging risks are presented, itemized according to the extent of known causality between a chemical and a health effect. Recommendations to improve the collection of chemicals that cause emerging risks will be given in Chapter 8.

2 Definitions

2.1 Occupational disease

Exposure to chemicals at the workplace may lead to adverse health effects in workers and may ultimately lead to disease or death. The number of deaths was estimated to be 1,850 per year in the Netherlands (Baars et al., 2005). The percentage of Dutch workers that developed an occupational disease because of exposure to chemicals was estimated to be 1.2% in 2011 by the Netherlands Centre for Occupational Disease (NCOD). The percentages of dermal diseases and respiratory diseases in the group of occupational diseases reported was 2.7% and 1.8% respectively (NCOD, 2012). In reality, these percentages are most likely higher because of registration problems in the Netherlands. Although occupational physicians are obliged to report occupational disease to the NCOD, there is no strong incentive to report. An online enquiry conducted among occupational physicians suggested that occupational diseases were only reported by those who were intrinsically motivated to do so. The enquiry also showed that there are barriers between workers and occupational physicians which impedes the reporting of occupational diseases. These barriers include factors such as legislation, enforcement and the establishment of health and safety services. A decrease in the frequency of periodical medical examinations performed on workers (PMO) and consultations with occupational physicians concerning working conditions (CWC) impedes the reporting of occupational diseases. It has become more difficult for workers who are 'not absent due to illness' to consult an occupational physician. This is because of a strong focus on absence and reintegration, the increased use of case managers instead of occupational physicians, the disappearance of the binding CWC, the increase in restricted contracts, reduced time to visit workplaces by the occupational physician and the possibility of legal claims and negative reactions from clients as a result of a diagnosed occupational disease (Lenderink, 2012). Also, the tendency of an employee not to trust the occupational physician to give medical information to the employer is a reason for him not to participate in a PMO.

It is important to define occupational or work-related disease. There are several definitions, but a number of elements are essential:

1. The exposure-effect relationship must be clearly established through
   a. clinical and pathological data and
   b. knowledge of the occupational background and
   c. job analysis to gain insight into (historical) exposure to the suspected chemical
2. Epidemiological data are useful for determining the exposure-effect relationship of a specific occupational disease.

The relationship between work and disease was described in the following way by the International Labour Organization (ILO, 1993):

- "occupational diseases, having a specific or a strong relation to an occupation, and generally having only one causal agent, and recognized as such;
- work-related diseases, with multiple causal agents, where factors in the work environment may play a role, together with other risk factors, in the development of such diseases, which have a complex aetiology;
- diseases affecting working populations, without a causal relationship with work, but which may be aggravated by occupational hazards to health."

Concerning work-related diseases, the ILO only concentrates on diseases. As a consequence, early health effects will not be identified. The European Union's definition is broader in that respect and, for that reason, has been chosen in this study.

The European Union (EC, 2013):

- "A case of occupational disease is defined as a case recognized by the national authorities responsible for recognition of occupational diseases. The data shall be collected for incident occupational diseases and deaths due to occupational disease;
- Work-related health problems and illnesses are those health problems and illnesses which can be caused, worsened or jointly caused by working conditions. This includes physical and psychosocial health problems. A case of work-related health problem and illness does not necessarily refer to recognition by an authority and the related data shall be collected from existing population surveys, such as the European Health Interview Survey (EHIS) or other social surveys."

2.2 Emerging, new and increasing risks

In discussions on new work-related health effects caused by chemicals, it is often not particularly clear what is meant by emerging, new and increasing risks. There are several definitions on new and/or emerging risks. The Social and Economic Council of the Netherlands (SER) defined 'new risks' as follows: "new occupational health risks to which employees are exposed due to changes in production processes and work methods, or to changes in working conditions. This includes risks that are already known or should be known, as well as risks that are (as yet) unknown, but are discovered through new information. Risks that have been known for some time, and for which the process of signals, prevention and recovery is largely in place, are outside the scope of this description" (SER, 2002).

This report focuses not only on chemicals that cause work-related health problems due to a lack of knowledge about the hazard, exposure and/or risk, but also on chemicals whose risks have already been identified but that, nevertheless, cause work-related health problems due to a failure to respect safety instructions or a lack of enforcement due to things such as lagging social or public interest. For this reason, the broader definition of EU-OSHA is used in this report, which identifies **emerging risks** as both new and increasing risks (EU-OSHA, 2009):

"New risks:

- the issue is new and caused by new types of substances, new processes, new technologies, new types of workplaces, or social or organizational change; or
- a longstanding issue is newly considered as a risk due to a change in social or public perceptions (e.g. stress, bullying); or
- new scientific knowledge allows a longstanding issue to be identified as a risk (e.g. repetitive strain injury (RSI), cases of which have existed for decades without being identified as RSI because of a lack of scientific evidence).

Increasing risks:

- number of hazards leading to the risk is growing; or
- likelihood of exposure to the hazard leading to the risk is increasing,

(exposure degree and/or the number of people exposed); or
- effect of the hazard on the workers' health is getting worse."

3 Methods to identify emerging risks

The identification of emerging risks requires several complementary methods. The proper method depends on the characteristics of the health problems to be investigated, such as its nature and seriousness, and the strength of the causal link with the exposure. In case of a rare disease with a strong aetiological relationship between work and the health complaints, a clinical watch system is more suitable than epidemiological research such as case control, or prospective or retrospective cohort studies. In a clinical watch system, cases of health impairment are reported and disseminated among professionals with the intention investigating a possible causal relationship between the exposure and the reported health effects. Stimulating and registering 'spontaneous reports' by physicians or employees would be a good instrument in the case of a rare disease with a high aetiological factor. Epidemiological research among large groups of employees is more appropriate in cases of frequently-occurring health effects with a low aetiological relationship. A different kind of research is cluster analysis, which investigates a series of coincident cases (time and place coincidence). A fourth method to investigate emerging risks is to perform health surveillance among exposed workers. In this way, the primary focus is not on the health effect, but on the exposure. Health surveillance can be used as an early warning system for the unknown effects of exposures, for example exposure to nanoparticles.

A good overview of existing methods to detect the signs of occupational health risks (signal detection) was published by the NCOD (NCOD, 2009). Various methods exist to track down possible relationships between work or working conditions and health problems. A short overview of the different methods and their advantages and limitations is given below.

3.1 Collection of case reports (clinical watch system)

The collection of 'spontaneous' case reports is a very important source of information for the identification of emerging risks. This tool is especially effective in cases of rare, serious health effects with a low incidence rate. The notifier suspects a relationship between the health effect and exposure to chemicals and/or an occupation. It is an effective, relatively inexpensive method that covers the whole working population. Drawbacks of this method are dependence on the willingness to notify (underreporting) and the need for further research on a possible causal relationship. These case reports are collected in a database. Examples of important databases are THOR (UK), RNV3P (France) and NIOSH (US). At this moment the NCOD is developing a reporting system for emerging risks for occupational physicians. More information on organizations analysing case reports is presented in Chapter 4.

Case reports may be presented by occupational physicians, general practitioners or medical specialists. These notifiers all have their own typical advantages and limitations, such as the workers accessibility to the professional, knowledge of the working conditions, knowledge of the connection between work and health. Workers may also report a case, but there is a higher risk of irrelevant information in this case because of a lack of knowledge on work relatedness.

3.2 Periodic literature screening

Systematic literature searches, both in scientific literature databases and on

important websites of organizations engaged in the identification of emerging risks, is an important method to track emerging risks as soon as possible. On the one hand, relationships found in the collection of case reports can be strengthened if additional cases are reported elsewhere. On the other hand, unknown relationships from literature (case reports or cluster analysis) may serve as a trigger to search databases of collected case reports.
Since it takes some time to publish a case report or a cluster analysis in a scientific paper, it is important to include websites of important organizations in the literature search. Since the amount of information is huge, text mining techniques may be a solution. Text mining is based on a unique ontology[1], developed for the type of research. It will identify all known and unknown linguistic relationships between chemicals, occupational exposure and health effects in the databases and websites searched. In this way, text mining will drastically reduce the amount of publications that need further action. An example of a text mining tool in food research is ERIS-food, which was developed by TNO. At this moment, TNO is developing a similar tool for worker exposure to chemicals.

3.3 Data mining

Data mining in databases of case report notification registries is a valuable tool for epidemiological research. Relationships between health effects and exposure and/or occupation can effectively (objectively and reproducibly) be studied, especially when exposure data are incorporated in the database. This type of research results in the formation of a hypothesis. Further research is necessary to investigate a possible causal relationship between the exposure and the health effect.

3.4 Active detection via health surveillance

The active detection of health effects via health surveillance of workers is a valuable tool. Workers with known similar exposures receive periodical medical check-ups. This prospective method is useful since a causal relationship between the level of exposure and possible health effects is easier to prove. Drawbacks of this method are the need for large groups of exposed workers, it is relatively time consuming due to a long follow-up time and it is an expensive way of research.

3.5 Secondary analysis of other sources

Databases other than the databases of case reports can be a valuable tool for generating hypotheses for emerging risks. Examples are electronic files from general practitioners, cause-of-death statistics, disease registries, and employee insurance administration agency (UWV) files. Secondary analysis of the data may reveal unknown relationships between health effects and occupation provided information on occupation and/or exposure is supplied. Unfortunately, this is often not the case.

The next chapter will describe the initiative of MODERNET (Monitoring trends in Occupational Diseases and tracing new and Emerging Risks in a NETwork) in which several of the methods described above are used to track emerging risks of chemicals.

[1] Ontology: textual relationship between huge quantities of terms

4 Organizations analysing emerging risks

The main national (Dutch) and international organizations that gather and analyse emerging risks have been selected and are presented in Table 1. These organizations will be discussed further in this section. In addition, there are a large number of organizations with important practical experience, which therefore might be in the position to detect emerging risks. These organizations are presented in Annex 1.

Table 1. Organizations generating information on emerging risks for workers.

Organization	**Information source**	**Description**	**Reference**
ILO	CISDOC database	The CIS bibliographic database contains about 70,000 citations of documents that deal with occupational accidents and diseases, as well as ways of preventing them.	ILO CISDOC database
EU-OSHA	Database of publications		EU-OSHA Database of publications
EEA	Reports on emerging risks	The 'Late Lessons Project' reports illustrate how damaging and costly the misuse or neglect of the precautionary principle can be, using case studies and a synthesis of the lessons to be learned and applied to maximizing innovations whilst minimizing harms.	EEA publications, EEA (2001), EEA (2013)
SCENIHR	Alert mail C7 Risk Watch	Electronic newsletter with hyperlinks to emerging science issues.	Was available via SCENIHR members in the past. It is not clear whether Risk Watch still exists
NIOSH	NIOSHTIC-2 database	Bibliographic database of occupational safety and health publications, documents, grant reports, and other communication products supported in whole or in part by NIOSH.	NIOSHTIC-2 database
NIOSH	NIOSH Health Hazard Evaluation (HHE) Reports	An HHE is a study of a workplace, performed to learn whether workers are exposed to hazardous materials or harmful conditions.	NIOSH Health Hazard Evaluations

Organiza-tion	Information source	Description	Reference
NIOSH	E-news	Monthly newsletter	NIOSH e-news
MODERNET	Expert network	Enhancement of knowledge based on recognizing trends in Occupational Diseases, as well as discovering and validating new occupational health risks, through collaboration and the exchange of knowledge and expertise.	MODERNET webpage
NCOD	Reporting tool Reports on emerging risks	The NCOD registers and reports occupational diseases via the national notification and registration system and a number of specific surveillance projects.	NCOD webpage
BfR	Press releases	Regular press releases	BfR press releases

4.1 International Labour Organization (ILO)

Creating safe and healthy working conditions is a challenge to which the ILO has been responding since it was founded in 1919. As our world develops, with new technologies and new patterns of work, the challenges change and new risks emerge. The Governing Body of the International Labour Office (ILO) approved a new list of occupational diseases at its meeting on 25 March 2010. Designed to assist countries in the prevention, recording, notification and, if applicable, compensation of diseases caused by work, this new list replaces the one in the Annex to the Recommendation concerning the List of Occupational Diseases and the Recording and Notification of Occupational Accidents and Diseases (No. 194) which was adopted in 2002. This new list of occupational diseases reflects the state-of-the art development in the identification and recognition of occupational diseases in the world of today. However, the list has its limitations as new occupational diseases are not taken into account.

4.2 European Agency for Safety and Health at Work (EU-OSHA)

The European Agency for Safety and Health at Work is active in the field of risk prevention and working conditions improvement in Europe. The fields of interest include both chemical risks as well as non-chemical risks, covering all working conditions. The main topic of interest relevant for this report is ‘dangerous substances’. This topic includes information on REACH, CLP, risk assessment, OELs, and health effects, amongst others.

The European Agency for Safety and Health at Work published a European Risk Observatory Report on emerging chemical risks (EU-OSHA, 2009). The Community strategy on health and safety at work for 2002-2006 called on the Agency to ‘set up a risk observatory’ and to ‘anticipate new and emerging risks’ in order to tackle the continuously changing world of work and the new risks and

challenges it brings. The Community strategy for 2007-2012 reinforced the European Risk Observatory's role and explicitly mentioned the identification of new risks and dangerous substances as a research priority.
The ERO provides an overview of safety and health at work in Europe, describes the trends and underlying factors, and anticipates changes in work and their likely impact on occupational safety and health. The sources to identify new and emerging risks may cover data from official registers, the research literature, expert forecasts or survey data (e.g. questionnaires sent to (emerging) industries).

The results of this expert survey on emerging chemical risks are based on scientific expertise and should be seen as a basis for discussion among stakeholders to set priorities for further research and actions. Three consecutive questionnaire-based surveys were conducted using the Delphi method, in which the results of the previous survey round are fed back to the experts for further evaluation until a consensus is achieved. Forty-nine experts from 21 European countries participated in the survey. They identified five groups of emerging risks:

1. Particles; more specifically nanoparticles, diesel exhaust, Man Made Mineral Fibres (MMMF);
2. Allergenic and sensitizing agents; more specifically epoxy resins, isocyanates, dermal exposure (there is no validated scientific method to assess dermal exposure to dangerous substances, and no 'dermal' occupational exposure limits (OELs);
3. Carcinogens, mutagens and reprotoxic substances (CMRs); more specifically asbestos, crystalline silica, wood dust, organic solvents, endocrine disruptors, persistent organic pollutants, aromatic amines, biocides, azo dyes and combined exposures;
4. Sector-specific chemicals; dangerous substances in the construction sector and in waste treatment were highlighted as emerging risks;
5. Combined risks; in addition to mixed dangerous substances, combined chemical and psychosocial risks were identified, such as the poor control of chemical risks in small and medium-size enterprises (SMEs) – which make up 99.8% of all businesses – and increasing subcontracting practices, e.g. in maintenance and cleaning, whereby subcontracted workers are less aware of chemical risks and hence more vulnerable to dangerous substances.

In addition to the forecasts by the ERO, EU-OSHA keeps track of their publications, which include fact sheets, reports, literature reviews, articles, and holds a forum on interested topics. EU-OSHA also releases a newsletter monthly, OSHmail, which contains the latest news and links to the publications. The information can be accessed and searched by following: http://osha.europa.eu/

Overview of relevant fact sheets, reports, OSHmails and other sources:

- Fact sheet (84) on emerging risks (summary of ERO forecast described above): diesel because of IARC classification, isocyanates, epoxy resins, chemical mixtures in SMEs, MMMFs;
- Fact sheet (88) on maintenance workers exposed to chemical mixtures, to chemicals while working in confined spaces;
- Fact sheet (86) on preventing harm to cleaners: chemical related effects such as skin disease, respiratory effects and cardiovascular diseases are mentioned;
- Fact sheet (51) asbestos in construction;
- Report on new and emerging risks with green technology, including nanoparticles, green construction, waste treatment (most relevant);

- Report on occupational skin diseases and dermal exposure (no substances mentioned);
- OSHmail (87): reproduction toxic potential of aluminium and related compounds;
- OSHmail (92): combination of noise and the ototoxicity of chemical substances (solvents BTEX, manganese, asphyxiates, nitriles);
- OSHmail (101) crystalline silica in construction industry.

4.3 European Environment Agency

The European Environment Agency published two reports on emerging risks; 'the late lessons from early warnings'. In the first report (EEA, 2001), twelve key lessons were drawn by analysing historical cases of emerging risks. It looked at the history of a selection of occupational, public health and environmental hazards and asked whether we could have been better at taking action early enough to prevent harm. The twelve key-lessons were drawn from cases in which public policy was formulated against a background of scientific uncertainty and 'surprises', and in which clear evidence of hazards to people and the environment was often ignored. The twelve late lessons are:

1. Acknowledge and respond to ignorance, as well as uncertainty and risk, in technology appraisal and public policymaking;
2. Provide adequate long-term environmental and health monitoring and research into early warnings;
3. Identify and work to reduce 'blind spots' and gaps in scientific knowledge;
4. Identify and reduce interdisciplinary obstacles to learning;
5. Ensure that real world conditions are adequately accounted for in regulatory appraisal;
6. Systematically scrutinize the claimed justifications and benefits alongside the potential risks;
7. Evaluate a range of alternative options for meeting needs alongside the option under appraisal, and promote more robust, diverse and adaptable technologies so as to minimize the costs of surprises and maximize the benefits of innovation;
8. Ensure use of 'lay' and local knowledge, as well as relevant specialist expertise in the appraisal;
9. Take full account of the assumptions and values of different social groups;
10. Maintain the regulatory independence of interested parties while retaining an inclusive approach to information and opinion gathering;
11. Identify and reduce institutional obstacles to learning and action;
12. Avoid 'paralysis by analysis' by acting to reduce potential harm when there are reasonable grounds for concern.

These key-lessons are still important today and formed the basis for a second report (EEA, 2013). The main reasons to make a second report are summarized below:

1. The first reason relates to expanding the late lessons approach to consider long known, important additional issues with broad societal implications, such as lead in petrol, mercury, environmental tobacco smoke and DDT, as well as issues from which lessons have emerged more recently, such as the effects of the contraceptive pill on the feminisation of fish and the impact of insecticides on honeybees;
2. The second reason concerns filling an acknowledged gap in the 2001 report by analysing the issue of false positives such that government regulation was undertaken based on precaution which later turned out to be unnecessary;

3. The third reason is to address the rapid emergence of new society-wide challenges such as radiation from mobile phones, genetically modified products, nanotechnologies and invasive alien species, as well as the question of whether, how and where precautionary actions can play a role;
4. The final reason relates to how precautionary approaches can help manage the fast-changing, multiple, systemic challenges the world faces today.

Most of the cases examined in both reports are false-negatives, which means that early warnings existed but no preventive actions were taken. The examples illustrate that many lives would have been saved if the precautionary principle had been applied based on early warnings, justified by 'reasonable grounds for concern'. Warnings were ignored or sidelined by companies that put short-term profits ahead of public safety or by scientists that down-played risk, sometimes under pressure. We keep making mistakes because of a lack of institutional and other mechanisms to respond to early warning signals, a lack of ways to correct market failures, and the fact that key decisions on innovation pathways are made by those with vested interests and/or by a limited number of people on behalf of many. Besides relying on science and knowledge, it is also important to interact with governments, policymakers, businesses, entrepreneurs, scientists, civil society representatives, citizens and the media.

The problem of emerging risks is becoming increasingly important because of the fact that technologies are now taken up more quickly than before and adopted around the world. The second report recommends the wider use of the 'precautionary principle' to reduce hazards in cases of new and largely untested technologies and chemicals. It is stated that scientific uncertainty is not a justification for inaction when there is plausible evidence of potentially serious harm. Since there is debate about the number of false positives using the precautionary principle, 88 cases of supposed 'false alarm' were analysed. Only four clear cases of 'false alarm' were found. This shows that fear of false positives is misplaced and should not be used as a rationale for avoiding precautionary actions (EEA, 2013).

4.4 SCENIHR

SCENIHR is the Scientific Committee on Emerging and Newly Identified Health Risks. The Committee provides opinions on emerging or newly-identified health and environmental risks and on broad, complex or multidisciplinary issues requiring a comprehensive assessment of risks to consumer safety or public health and related issues not covered by other Community risk assessment bodies.
Potential areas of activity include:

- antimicrobial resistance ;
- new technologies (e.g. nanotechnologies);
- medical devices, including those incorporating substances of animal/human origin;
- physical hazards (e.g. noise, electromagnetic fields);
- tissue engineering;
- blood products;
- fertility reduction;
- cancer of endocrine organs;
- the interaction of risk factors, synergic effects, cumulative effects;
- methodologies for assessing new risks.

It may also be invited to address risks related to public health determinants and non-transmissible diseases.

An advisory structure on scientific risk assessment in the areas of consumer safety, public health and the environment is thus established. This structure includes:

- the Scientific Committee on Consumer Safety (SCCS);
- the Scientific Committee on Health and Environmental Risks (SCHER);
- the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR);
- a Pool of Scientific Advisors on Risk Assessment (the Pool), which will support the activities of the Scientific Committees in accordance with the relevant provisions of this Decision.

The Risk Watch is an electronic newsletter from SCHER, SCENIHR and DG SANCO Unit C7. It contains hyperlinks to emerging science issues, selected by experts from the committees. Sources include scientific journals, national institutes (BfR, Danish EPA, ANSES, etc.) and information from websites. The expert opinions enable early detection of emerging risks. The Risk Watches of 2009-2012 were available and were screened for emerging risks.

4.5 NIOSH

NIOSH is the National institute for Occupational Safety and Health in the United States, as part of the Centre for Disease Control and Prevention (CDC). In the US, OSHA is responsible for the development and enforcement of legislation and the NIOSH covers research and education on occupational safety and health (please note that EU-OSHA activities are comparable to NIOSH, but different from the US OSHA).

With respect to the aim of this report, the most relevant publication type is the 'alert' NIOSH issues when considered necessary. Alerts published by NIOSH are:

- Beryllium exposure and skin and respiratory disease by sensitization in numerous industries; (2011)
- Lead and noise at firing ranges (2009)
- MDI in spray-on truck bed liner (2006)
- Lung disease in workers making flavourings (2003)

To search for new possible risks, one is advised to check all recent publications including the NIOSH e-News. A quick search showed a more recent 'infosheet' on protecting workers who use cleaning agents, including the so-called green cleaning agents. All NIOSH publications are searchable using the database NIOSHTIC-2.

The NIOSH website also contains a database on Health Hazard Evaluations (HHEs). According to NIOSH: "Employees, employee representatives, or employers can ask NIOSH to help them learn whether health hazards are present at their place of work. NIOSH may provide assistance and information by phone and in writing, or may visit the workplace to assess exposure and employee health. Based on their findings, NIOSH will recommend ways to reduce hazards and prevent work-related illness. The evaluation is done at no cost to the employees, employee representatives, or employers." HHEs performed by NIOSH will be included in the database and are accessible thereafter. It may provide valuable information on possible unsafe worker situations. An overview of a selection of HHEs where chemicals are responsible

for the reported health effects is presented in Chapter 7.

4.6 MODERNET

The EU strategy for health and safety at work (2007-2012) aims to reduce the incidence of occupational diseases. One of the actions needed to achieve this goal is a better identification and assessment of potential new risks through more research, exchange of knowledge and practical application of results (EC, 2007).
The activities of the EU-OSHA Bilbao Risk Observatory and Helsinki REACH Information Centre are aimed at identifying novel causes from a risk-perspective. The rather new initiative MODERNET (Monitoring trends in Occupational Diseases and tracing new and Emerging Risks in a NETwork) identifies possible novel causes from the perspective of the health consequences of emerging risks by studying reported cases and health statistics ('disease first approach'). To detect and validate emerging risks, it is necessary to collaborate by facilitating the exchange of knowledge and information. MODERNET serves as an intelligence centre for providing strategic information on work-related and occupational diseases, including emerging risks for governments and private entrepreneurs. The main objective is to create this 'intelligence network' by creating facilities to exchange knowledge on new techniques in order to enhance the information on trends in occupational diseases (i.e. record linking, surveys), on discovering and validating new risks more quickly (data mining, workers' reporting) and the use of modern techniques to discuss and disseminate information to all stakeholders (platforms, social media). There is a wish to create a EU scientific committee on occupational diseases (SCOD) which could identify the diseases that need further evaluation; consider how such an evaluation should be carried out; agree what research is needed to provide the necessary evidence; and develop coordination mechanisms so that research and evaluation will be efficiently carried out (EC, 2013).

Regarding the discovery and validation of new risks, the MODERNET network uses qualitative methods based on the quick sharing of clinical cases of interest in terms of new aetiology or circumstances of appearance ('clinical signal'). The aim is to search similar cases in other countries ('signal strengthening') and build a common expertise upon these situations. In some cases, this may serve as an alert to EU and national institutions, occupational health physicians, employers and other preventive-measures stakeholders.

At the moment, MODERNET is developing a sentinel clinical watch system to be able to share cases among MODERNET members and other interested health professionals. Discussion on cases that are brought in will be possible via a web-based tool. A second method to trace emerging risks is screening published cases on a regular basis and sharing them among MODERNET members. Cases identified by the clinical watch system or by a literature search may be strengthened by searching for similar cases in databases managed by MODERNET members.

Interesting databases include THOR (United Kingdom) and RNV3P (France). THOR is a health and occupation reporting network of vigilant physicians. It is a voluntary reporting system for both proven and possible occupational diseases. THOR consists of a number of surveillance systems that are interesting in regard to chemical exposure:

- SWORD: Surveillance of Occupational & Occupational Respiratory Diseases
- EPI-DERM: Occupational Skin Surveillance

- OPRA: Occupational Physicians Reporting Activity
- THOR-GP: The Health and Occupation Reporting Network - General Practitioners

RNV3P is the French national occupational surveillance and prevention network and consists of 32 occupational disease clinics coordinated by ANSES. Besides identification and reporting of known occupational diseases, patients exhibiting no clear relationship between exposure and health effect are also referred to RNV3P. Both exposure and health effect are systematically investigated.

The databases of THOR and RNV3P can be used for more quantitative methods in order to detect previously unknown 'disease x exposure' or 'disease x exposure x occupational setting' relationships that seem to be more frequently reported than expected. Data mining methods are primarily interesting for generating a hypothesis. If a hypothesis seems strong enough, classical epidemiological studies may be conducted to analyse the specific questions raised. This step-wise approach is interesting since the exposure is more defined compared with epidemiological studies without this extra information. Besides methods based on the disease-first method, MODERNET also searches for comparable health effects among workers with similar exposures using the Geographical Information System (GIS).

4.7 Netherlands Centre for Occupational Diseases (NCOD)

The detection and analysis of occupational health risks is an important task of the Netherlands Centre for Occupational Diseases (NCOD). It is mandatory for occupational physicians to report occupational diseases to the NCOD (*beroepsziektenregistratie*). In addition, there are surveillance projects for motivated physicians (e.g. occupational skin diseases, occupational respiratory diseases and a Surveillance Project for Intensive Notification). More information about the situation in the Netherlands regarding the identification of emerging risks is contained in Chapter 5.

4.8 Federal Institute for Risk Assessment (BfR)

The German *Bundesinstitut für Risikobewertung* (BfR) assesses risks from many areas of daily life. This includes a large spectrum of chemicals as well as foods of plant or animal origin, cosmetics and toys. These are the tasks which are incumbent on the Federal Institute for Risk Assessment (BfR) when it comes to progressive consumer protection. They encompass the assessment of existing health risks and the identification of new health risks.
BfR gathers the latest scientific findings through an ongoing international exchange with experts from other scientific institutions, but also from its own research. The BrR is mentioned in this overview of organizations since emerging risks for consumers may also be of interest for workers.

5 Situation in the Netherlands regarding the identification of emerging risks

Dutch workers that have questions about possible negative health effects from exposure to chemicals might find it difficult to find help. This is especially the case when it concerns emerging risks, since professionals in occupational medicine and occupational hygiene often do not have the attitude of a scientist. So the current protocols to be followed can interfere with discovering new relationships between a chemical and a negative health effect.

The pathways that a worker who is seeking help with health-related questions can take are presented in Figure 1. The relationship between worker, employer/branch, health care providers and the government is presented and explained.

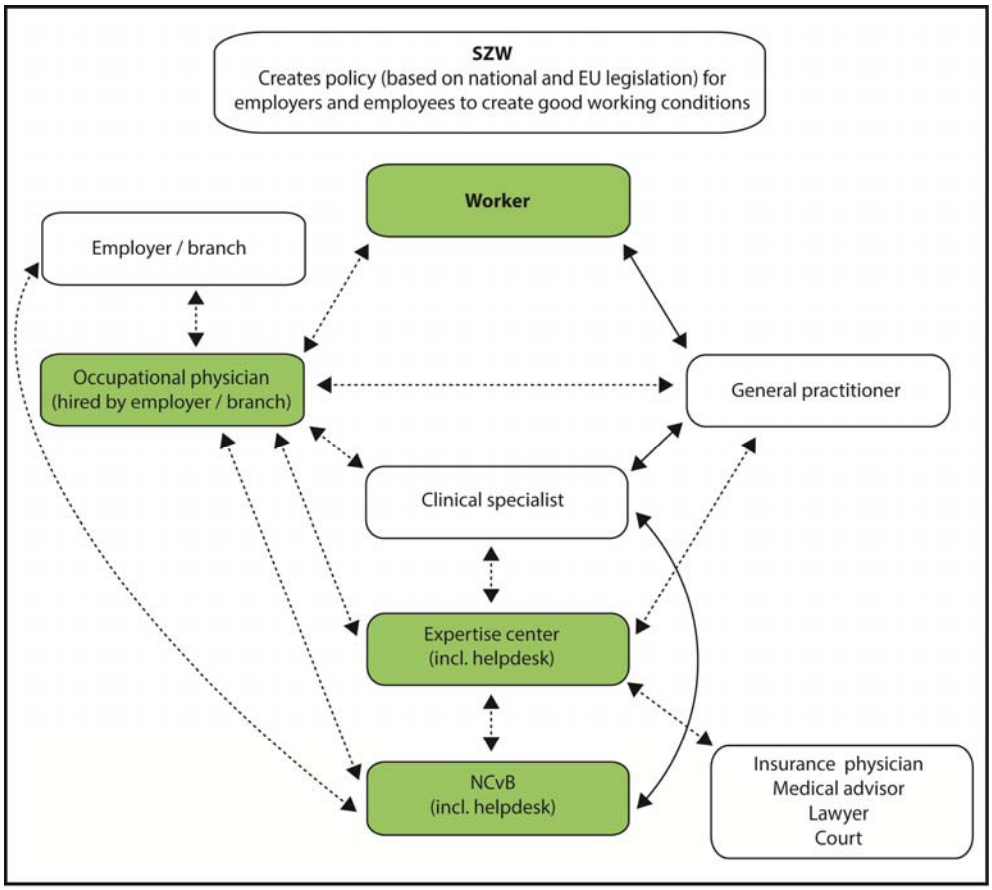

Figure 1. The health care system in the Netherlands from a workers point of view. The green coloured professionals or organizations are expected to be the main discoverers of emerging risks. Solid lines indicate publicly accessible services for insured workers; dashed lines indicate facilities with restricted access.

The Ministry of Social Affairs and Employment determines the legal framework for making a policy on working conditions, which is based on the Chemical

Agents Directive (98/24/EC). Within a company, both employers and employees (read workers) have to work together to put this policy into practice. The principle of the legal framework is a reduced number of legal obligations and an increased responsibility both for employers and workers. The Ministry of Social Affairs and Employment, the Ministry of Health, Welfare and Sport and the Social and Economic Council of the Netherlands are discussing the role of the occupational physician within the occupational health care system at this moment.

A worker looking for help from an occupational physician will not always succeed. If a worker falls ill because of exposure at the workplace, he can find help from an occupational physician provided that his employer contracted this professional, for example via an occupational health service, a self-employed occupational physician or an occupational physician employed by the company. As a consequence, self-employed workers are not part of the system and do not have access to occupational physicians. With the exception of several companies and industries, professional assistance is often not arranged for workers with work-related health effects without them being absent from work[2]. Expertise centres and the Netherlands Centre for Occupational Disease (NCOD) are reserved to answer questions when a worker seeks contact with their helpdesks. They prefer questions to be asked by occupational physicians, general practitioners or medical specialists. The expertise centre will try to redirect the question to the experts of an occupational health service or to a question asked by a health professional. Self-referral of workers to an expertise centre hardly exists. Also, workers cannot report an occupational disease directly to the NCOD.

The occupational physician can always consult the worker's general practitioner (GP). This in contrast to the general practitioner who is not always able to consult the worker's occupational physician since this professional is not always available (see above). The occupational physician can always refer a worker to a clinical specialist. The charges of the treatment will be paid by the basic health insurance as long as the activities are covered by the so-called diagnose treatment combination (DBC code[3]). However, among other disorders, the diagnosis of occupational asthma and contact eczema are not insured. In addition, insurance of the examination of the load of a patient with COPD is not generally arranged. In practice, the employer is asked to pay the bill in these situations, but if he is not willing to do so, the examination will not take place. Some medical specialists (dermatologists, pulmonologists) will report an occupational disease to the NCODs reporting system for medical specialists. This database can be used to validate the reports of occupational physicians. The occupational physician can also refer a worker to an expertise centre but finances are not arranged for examinations that are not covered by the DBC code. Either the employer or the (health) insurance of the worker has to be prepared to pay for the examination. An expertise centre will inform the worker's occupational physician if available, in a case of an occupational disease so that he can report the occupational disease to the NCOD. The occupational physician is legally obliged to report an occupational disease to the NCOD. An occupational physician sometimes seeks help from the NCOD, at first often via

[2] The Working Conditions Act provides assistance for the counselling of workers absent from work because of illness (Arbeidsomstandighedenwet, H2 art.14). This means that work-related health problems do not reach the occupational physician or do so only at a late stage (when there the worker is absent from work).

[3] Since 1 January 2012 DBC (Diagnose Behandel Combinatie) has been changed to 'DOT' which means 'DBC On the way to Transparency'

the helpdesk, before an occupational disease is reported. For every report there will be a standard back-report, but this is more formal because of research needs. Sometimes, the NCOD will contact the reporter in the case of a special report. If a report is not accepted, the reporter will be informed and told the reason for the rejection. In July 2013, NCOD introduced SIGNAAL, an e-tool for occupational physicians to report health issues caused by exposure to substances which might indicate emerging risks. A specialist of NCOD will analyse the signal and report back to the occupational physician. NCOD analyses all reports and informs the Ministry of Social Affairs and Employment. In some cases, a particular commercial sector will take an active role and stimulate medical examinations among the employees in the sector. Examples are the commodity board of grains, seeds and leguminous plants[4] in cases of baker's asthma and construction in cases of silicosis. Depending on the sector, they consult an expertise centre or an individual occupational physician.

A worker can always consult a general practitioner paid by the basic health insurance. Generally speaking, the general practitioner does not have much knowledge and experience of health-related problems caused by exposure at work. Therefore the general practitioner will refer the patient to:

- the clinical specialist if the health problem persists. The referral is paid by the basic health insurance, provided that the activities are covered by the DBC code;
- An expertise centre; finance depends on the patient's health insurance and/or the willingness of his employer to pay the bill;
- NB: a general practitioner cannot report an occupational disease to NCOD. As a consequence, workers such as self-employed workers will only occur in the databases of dermatologists and lung physicians.

Sometimes medical advisers (for injury or liability insurances) or insurance physicians (of UWV[5] or other insurers of loss of wages) seek contact with an expertise centre to ask whether health effects can be caused by chemical agents. A court or a worker's lawyer can also contact an expertise centre to underpin a case of injury. Questions of these kinds are not paid by the health insurance.

[4] Productschap granen, zaden en peulvruchten

[5] UWV is an autonomous administrative authority (ZBO) and is commissioned by the Ministry of Social Affairs and Employment (SZW) to implement employee insurances and provide labour market and data services.

6 Emerging risks and national and international legislation

REACH provides baseline protection for human health and the environment for both substances and mixtures. It covers industrial, professional and consumer uses as well as environmental release. So, whereas REACH includes worker safety issues, it also refers to the specific EU worker legislation, addressing more specific requirements and duties for those employers dealing with chemical substances. Brief descriptions of the different laws are presented below, with special attention given to the possibilities and gaps with respect to emerging risks of chemical substances.

In addition to REACH and CLP, product-specific legislation exists for Biocides, Plant Protection Products, Cosmetics and Medicine, which addresses worker safety. The specific product legislation is therefore included in the overview.

6.1 REACH and CLP

In Europe, the REACH regulation (1907/2006/EC) provides the general framework legislation for substances and mixtures. REACH, the regulation on the registration, evaluation, authorization and restriction of chemicals, is aimed at the safe use of chemicals in Europe. Registration is required for those substances produced or imported in quantities over one tonne per annum (tpa). The information requirements increase with higher tonnage produced or imported and if substances display specific hazard characteristics. REACH covers the import, production, use and waste stage of substances. Importers or producers need to register their substances at ECHA, the European Chemicals Agency, unless a substance is already fully covered by specific legislation like the plant protection products regulation (see Section 6.4).

Tonnage band related data requirements

Substances that require registration by industry and are produced or imported in amounts greater than 10 tpa and are hazardous according to the CLP Regulation or are PBT (persistent, bioaccumulative, and toxic) or vPvB (very persistent and very bioaccumulative) must have a chemical safety report (CSR) attached to the registration dossier. The CSR describes the processes, uses and environmental releases, hazard profile and a risk characterization of the substance, indicating their safe use. Industry is responsible for the registration dossiers and the CSR. This way, the legislation assures that the high volume chemicals are covered and have been evaluated by industry for their possible risks. It should be noted that for substances classified as dangerous, but not as PBT or vPvB, and produced in amounts greater than 1 tpa and smaller than 10 tpa, an exposure assessment and CSR are not required.
Industry has to provide and enable information flows downstream and upstream on safe use and possible hazards and exposures identified with the substance and its (specific) use; this includes information regarding any health effects found in workers or consumers.

Options for evaluation of emerging risks

Under REACH, Member States and ECHA have the possibility to evaluate registration dossiers for their completeness and compliance with REACH, whereby it is assessed whether legal requirements have been fulfilled, including

the indication of safe use. Additional information within the REACH requirements may be requested, e.g. a 90-d repeated dose study by inhalation may be requested even if an oral 90-d repeated dose study is available, when there is sufficient reason to conclude that risks following inhalation exposure cannot be properly assessed from the oral study or in any other way.

Another option is to target those substances that are of concern. There are several possibilities. For example, placing a substance on the Community Rolling Action Plan (CoRAP) to initiate the process of Substance Evaluation, thus allowing information requests beyond the REACH regulation standard requirements in order to evaluate if the concern remains. If so, additional steps can be taken to either restrict or ban the use of the substance inside or outside the scope of REACH. Another option is that the substance can be placed on the Registry of Intention (RoI) to initiate the restriction process. A restriction dossier will be prepared by a Member State proposing a restriction and stating why that restriction is the best way to control the risks. Committees will evaluate whether there is indeed a risk and whether the restriction is proportional to reduce the risks. If a substance meets certain hazard properties, the substance is placed on the Candidate list. If prioritized, they are subject to Authorization. In this case, industry prepares an Authorization dossier for their specific use(s) of the substance, indicating the need for authorizing the use of the substance.

REACH has no specific procedure for identifying emerging risks. However, if Member States have identified an emerging risk, they can investigate whether the substance does actually entail a real risk and, if so, they can propose risk management options (including restriction or authorization) to mitigate the risks.

If, in regard to the emerging risk, it is unclear as to what exactly causes the impact on health, the substance evaluation process may be the preferred process to follow, whereas if the health effects and risks are clear, Member States may opt for restriction or authorisation under REACH or propose measures outside the scope of REACH if more appropriate.

It is difficult to identify emerging risks directly from evaluating the registration dossiers. Especially the information regarding detailed actual handling of the substance (by workers or in consumer products) and exposure information is often insufficient to detect early possible risks.

In addition, ‘traditional’ exposure and risk assessment may not be suitable to describe the newly developed issues leading to possible risks. Apart from the technical nature of the difficulties that arise in identifying emerging risks, there is also a practical difficulty. Due to the vast amount of substances, pragmatic approaches have been taken to deal with all those substance registrations. It means that not all dossiers are evaluated under REACH. Priorities have been given to high volume chemicals and hazardous chemicals (CMR, PBT, vPvB, and other SVHCs). The attention given to SVHC substances under Article 57f of REACH may be an especially interesting possibility for Member States to identify emerging risks and to target them, as there are no predefined criteria for the type of hazard and thus SVHC may include endocrine disruptors, immunological agents, and sensitizers, amongst other things, and future new hazards. The REACH legislation, on the other hand, requires less information on low production chemicals, so unknown risks associated with these chemicals are less likely to be identified. Substances produced in amounts under 1 TPA do not require registration at all.

To indicate all limitations and possible gaps in the REACH legislation would go beyond the scope of this report. Below a list is given of some of the possibilities whereby a substance or its use has not been given sufficient attention to safeguard the safe use of the substance, thereby increasing the likelihood that emerging risks have been overlooked.

- Substances produced or imported in amounts under 1 TPA are not registered. However, the substance can be used by, say specialists or hobbyists, and may present relatively high exposures to a small population, leading to possible high risks;
- Substances covered by other legislation (see Section 6.4). For example, the non-active ingredients (co-formulants) in biocides or plant production products are believed to be covered in the respective pieces of legislation covering those areas, whereas in practice this is hardly ever the case. The use of the substance in those products may be erroneously assumed to be dealt with in the other framework. Furthermore, not all populations are considered in some frameworks. For example, the manufacture of cosmetics is not dealt with in the Cosmetics Directive;
- Certain toxic endpoints and risks may not be considered at all for a substance due to the approach of increasing information requirements for the hazard and exposure profile of substances at increasing tonnage bands;
- Not all exposure routes in hazard assessments are considered. Most of the toxicological data involves the oral route of exposure. The dermal and inhalation routes of exposure in toxicity studies, which are generally more relevant for non-food exposure, are not considered. The lack of information on possible local effects, in particular, is missing for the inhalation route of exposure;
- Substances used solely as intermediate or as PPORD[6] are exempted from preparing a CSR. It is unclear how these substances are evaluated for possible risks;
- Dossiers that have not been updated when new uses have been introduced;
- Compounds for which it is not yet possible to perform a proper risk assessment, e.g. for sensitizers. Sensitization may be the most critical effect of a substance for which it is not possible to derive a safe level. Even personal protection equipment can be insufficient to prevent symptoms. Moreover, no validated animal test exists to identify respiratory sensitizers;
- No information on mixture effects, such as chemical reactions forming by-products, which may be relevant.

On 20 January 2009, the Regulation on the classification, labelling and packaging of substances and mixtures (CLP regulation (EC) 1272/2008) took effect. The CLP Regulation will, after a transitional period, replace the current rules on the classification, labelling and packaging of substances (Directive 67/548/EEC) and mixtures (Directive 1999/45/EC). The date by which substance classification and labelling must be consistent with the new rules will be 1 December 2010 and for mixtures 1 June 2015. The new act will complement the REACH Regulation on the registration, evaluation, authorization and restriction of chemicals.

With the classification, labelling and packaging of substances and mixtures, communication concerning the dangerous properties of substances and mixtures across the supply chain is ensured following a standardized and harmonized procedure. Furthermore, a manufacturer or importer of substances and/or

[6] PPORD: Product and process oriented research and development

mixtures must notify the ECHA about the classification within one month after their placement on the market or one month after they are physically introduced in the customs territory of the EU. The classifications are publicly available at the C&L inventory website hosted by ECHA (http://echa.europa.eu/web/guest/regulations/clp/cl-inventory).

The classification of a substance or mixture implicitly means that users in the supply chain and finally the retailers are obliged to inform their workers and downstream users about the hazard profile. The obligation to share this information depends on the hazard endpoints identified and the concentration limits that apply in that specific case. If a substance is used in pure form or in a mixture above that concentration limit, then the substance or mixture must be labelled. Furthermore, information must be provided concerning the substance and/or mixture on the safety data sheet and in the risk inventory and evaluation (RI&E) (see section 6.2). Because of a (stricter) classification, employers will have to take measures to reduce the risks to his employees, and must also label the products with pictograms, and hazard and safety phrases for sale to the general public. For this reason, the classification of a substance and/or mixture will have an impact on how the substance and/or mixture will be used throughout the entire supply chain. For example, a classification as a carcinogen or mutagen 1A or 1B under CLP will have far-reaching consequences in areas involving worker safety, biocides, pesticides, cosmetics and other legislation (see sections 6.2 and 6.4).

How the substances and mixtures are classified is therefore very important. In REACH and CLP, a substance may be classified either by harmonized classification or by self-classification. Harmonized classification is a legally binding classification of the substance or mixture and thus registrants must adopt the harmonized classification in their registration dossier. The harmonized classification is taken up in Annex VI of CLP. Self-classification is done by the producers or importers themselves. This can lead to the situation in which a single substance can have many different classifications, sometimes possibly under-classifying or over-classifying hazard endpoints, i.e. meaning a more tolerant or stricter classification.

The REACH legislation and CLP regulation includes/affects both the worker population and general population. The legal text of REACH refers to the general worker safety Directives, i.e. Directive 98/24/EC - risks related to chemical agents at work, Directive 89/391/EEC, and Directive 94/9/EC that describe the systems required to acquire safe situations (basically describing the RMM[7]), stating that the processes and uses under REACH should comply with these Directives. The combination of the worker legislation, REACH and CLP should protect the workers sufficiently, but may not be sufficient to identify emerging risks at an early stage. First, the worker safety legislation is described.

6.2 Worker safety legislation – EU/National level – Arbowet and Arbeidsomstandighedenbesluit

EU laws governing the protection of the health and safety of workers that work with chemical agents is spread over several pieces of legislation. Firstly, Framework Directive 89/391/EEC, further referred to as FD, lays down general duties for employers and workers concerning health and safety at work.

[7] RMM: Risk Management Measures

Secondly, the Chemical Agents Directive (CAD)[8] and the Directive on the protection of workers from the risks related to exposure to carcinogens or mutagens at work (CMD)[9] further elaborate and expand the general duties in the Framework Directive. In 2013 the European Commission will issue a proposal for an amendment to the Directive, expanding its scope to cover reprotoxic substances cat 1 and 2.

The basic duty of employers is the duty to ensure the safety and health of workers *in every aspect* related to the work (Article 5 FD). Within the context of his responsibilities, the employer shall take the measures necessary for the safety and health protection of workers, including the prevention of occupational risks and the provision of information and training, as well as provision of the necessary organization and means (Article 6 FD). This duty of care is not explicitly incorporated into the CAD and CMD, however Article 5 CAD states to protect workers "from risks to their safety and health arising, or likely to arise, from the effects of chemical agents that are present at the workplace or as a result of any work activity involving chemical agents". The CAD applies not only to classified substances, but also to *any* chemical agent which, whilst not meeting the criteria for classification as dangerous in accordance with CLP/GHS - Classification, labelling and packaging of substances and mixtures, still may result in a risk to the worker because of its physico-chemical, chemical or toxicological properties and the way it is used or is present in the workplace.

The employer must be in possession of an assessment of the risk in accordance with Article 9 FD. Based on the assessment, the employer must take the necessary preventive measures set out in Article 6 FD and risks must be eliminated or reduced to a minimum following the hierarchy of prevention measures. The employer must ensure that the risk is eliminated or reduced to a minimum, preferably by substitution (replacing a hazardous chemical agent with a chemical agent or process which is not hazardous or less hazardous). Regarding chemical substances, it states that for any chemical agent for which a binding occupational exposure or biological limit value is established at Community level, Member States must establish a corresponding national binding occupational exposure level (OEL) or biological limit value that does not exceed the Community limit value. At any rate, the exposure to hazardous substances should be kept below the occupational exposure limit. "In any event, where an occupational exposure limit value effectively established on the territory of a Member State has been exceeded, the employer shall immediately take steps, taking into account the nature of that limit, to remedy the situation by carrying out preventive and protective measures." (Art. 6(5) CAD). It may be inferred from the wording of Article 4 CAD that the employer must actively gather information concerning classification as well as Risk Management Measures. Also, Article 4 CAD refers to information resulting from 'health surveillance'. Health surveillance is particularly interesting for tracing slowly developing or hidden ailments, such as sensitization or damage to genetic material. The preventive measures "shall be accompanied by health surveillance [..] if it is appropriate to the nature of the risk." Health surveillance is deemed "appropriate where the exposure of the worker to a hazardous chemical agent is such that an identifiable disease or adverse health effect may be related to the exposure" (Art. 10 CAD, also Art. 14 CMD). Furthermore, there shall be valid

[8] Council Directive 1998/24/EC of 7 April 1998 on the protection of the health and safety of workers from the risks related to chemical agents at work (consolidated version 28-6-2007).

[9] Council Directive 2004/37/EC on the protection of workers from the risks related to exposure to carcinogens or mutagens at work (Pb L158)

techniques for detecting indications of the disease or effect. Annex II of the CMD supplies practical recommendations for the health surveillance of workers.

At a national level, in the Netherlands, the abovementioned worker safety legislation is translated into the Working Conditions Act (*Arbeidsomstandighedenwet*) and the Occupational Safety and Health Decree (*Arbeidsomstandighedenbesluit*). A Risk Inventory and Evaluation (RI&E) is required for employers according to Article 5 of the Working Conditions Act. According to Article 4.2 of the Occupational Safety and Health Decree, this should include exposure and risk assessment of dangerous substances they either produce, store, transport or use, including formation of by-products.

In the Netherlands, OELs (in Dutch: *grenswaarden*) are in principle derived following a private route (those OELs are generally referred to as '*bedrijfsgrenswaarden*') or following the public route. The latter route is followed when a dangerous substance is without a legal representative or when the EU SCOEL or the Health Council of the Netherlands deems it necessary to derive an OEL. If the latter route is followed, this will result in a legally binding OEL, although it is noted that the SCOEL sometimes derive indicative OELs, allowing EU Member States to deviate from this value. In general, the data demands for the OEL are high, including higher tier toxicity endpoints such as long-term repeated dose studies and carcinogenicity. However, in practice, OELs will be derived despite data gaps.

Arrangements must be made on a national level for carrying out appropriate health surveillance of workers for whom the results of the assessment made by the employer reveal a risk to health (in accordance with the EU worker safety Directives). Individual health and exposure records must be made and kept up to date for each worker who undergoes health surveillance. The individual worker must have access to his personal records. Where, as a result of health surveillance, a worker is found to have a disease or an adverse health effect associated with exposure at work to a hazardous chemical agent or a binding biological limit value is found to have been exceeded, then the worker must be informed by the (company) doctor. The doctor will provide him with information and advice regarding any health surveillance, which he should undergo following the end of the exposure. In addition, other employees potentially exposed to the same agent should be informed and, if they consent to it, will be included in the health surveillance.

The Ministry of Social Affairs and Employment issues a list of substances which have carcinogenic, mutagenic and toxic reproduction properties, the so-called CMR-list on its website. If employees use such substances they are required to apply the occupational hygiene strategy set out in the Worker Safety Directive stating that such substances should be replaced where possible. If replacement is not possible, the highest level of containment should be looked for before other RMMs are considered, like personal protective equipment. This includes substances formed during production processes.

6.3 Worker protection covered by REACH, CLP and Worker Safety Directive

The combination of Worker safety legislation and REACH or product-specific legislation should assure the safety of workers and the sharing of vital information. Nevertheless and despite all measures, there may still be information gaps and procedural pitfalls that prevent the identification of emerging risks. Some pitfalls are mentioned above under the REACH legislation,

but others are more specific to the worker situation:

- The registration of complaints is primarily done at a national level and may grow to the European level. The registration of complaints is not consequently linked to REACH, while information sharing is a vital part of REACH. Picking up the complaints of workers therefore depends heavily on the national infrastructure for dealing with complaints, which is not the same across all countries. This hampers the identification of emerging risks;
- The RI&E and SDS of employers are predominantly based on known information from REACH and CLP, where no active attitude is present to search for possible, so far unidentified risks;
- Inspectorates/authorities controlling the workplace focus on known risks based on the RI&E and their personal experience. Their attention focuses on enforcement of the legislation and dangerous substances as classified under CLP (or previous legislation);
- Although REACH refers to the worker safety Directives, in practice REACH does not require industry to apply the occupational hygiene strategy in their registration dossiers, especially the first item, i.e. replacement of the substance;
- REACH legal text on the exposure scenario in the CSR lacks the level of detail that is needed for a proper description of the exposure scenario and certainly does not match the level of detail of a description of a workplace. In other words, a registrant can comply with the legislation, while the description of the exposure scenario made is too vague, making an evaluation of it impossible. As a result of this:
  - The exposure scenarios often are unclear or too generic. The exposure estimates are often based on measurements or calculations of comparable work situations, i.e. standard exposure estimates for process categories (PROCs), while the actual work situation is not covered at all by those measurements or calculations;
  - RMMs are used to reach safe levels, but may not reflect reality or are insufficiently documented. Furthermore, the occupational hygiene strategy is not followed in most cases;
  - It is unclear whether there is co-exposure to other substances;
  - It is unclear what the other activities are for a worker, i.e. different shifts of exposure;
  - As a result of the above, a clear discrepancy exists between the CSR (from REACH) and the RI&E (Worker Safety Directives), prohibiting any attempt to crosscheck the data.
- The REACH registrant may derive worker DNELs or use public OELs. However, DNEL and OEL derivations follow different methodologies. Furthermore, OELs are derived for the inhalation route only and thus a registrant under REACH must derive a dermal DNEL (if applicable);
- Toxicity testing according to REACH follows a tiered approach, while for the derivation of OELs a more demanding dataset is requested. However, in both frameworks it suffices to test one exposure route and to apply route-to-route extrapolation. This may be possible for systemic effects, but not for local acting agents, e.g. respiratory sensitizers. Or if there is route-specific toxicity, which in such a case obviously is unknown, it would give a false representation of the toxicity. A local DNEL for inhalation or dermal exposure cannot be derived. Such local effects however may be the critical endpoint and can be crucial to determining what RMM or personal protective equipment is necessary. Especially when known substances are used in new ways, thus leading to another route of exposure, unforeseen health effects may result, though the registrant might still be in compliance with

legislation.

6.4 Product-specific legislation – relevant for workers

Product-specific legislation describes legislation that has been made solely for a product group — such as biocides, agrochemicals, cosmetics, toys, (veterinary) medicine and food/feed stuffs. Of these, medicine and food/feed stuffs are exempted from REACH. Plant Protection Products (PPP) and Biocides are not exempted from REACH, however, and Article 15 of REACH states that if a substance is manufactured and used solely for the purpose of PPP and biocide, then the requirements mentioned under Chapters 1 to 5 of Title II: registration of substances will be regarded as being fulfilled. Between the specific pieces of legislation for PPP and biocide and REACH, an information gap exists when the substance is used solely for the purpose of PPP or biocide. The manufacture of the substance and/or PPP or biocide product and possible risks for the worker are not, in this specific case, considered under the specific pieces of legislation nor under REACH. In all cases, the worker safety Directives, as stipulated above, apply to the product-specific legislation.

Plant Protection Product and Biocidal Product legislation

The Plant Protection Products Regulation (PPPR, 1107/2009/EC) and the Biocidal Product Directive (BPD, 98/8/EC, soon to be replaced by the Biocidal Products Regulation 528/2012/EC) have their own authorization mechanism. The PPPR has its own authorization requirements for active substances, synergists and safeners, as well as a negative listing of unacceptable co-formulants in Annex III of that directive. The BPD has its own authorization mechanism for active ingredients. Both a positive and a negative listing of the active substances in biocidal products exist, resulting from this authorization obligation. BPD has no specific requirements for co-formulants, except for those co-formulants that are substances of concern (SoC). Substances of concern are defined as "any substance, other than the active substance, which has an inherent capacity to cause an adverse effect to humans, animals or the environment and is present or is produced in a biocidal product in sufficient concentrations to present risks of such effects" (Milieu ltd, Environmental law and policy 2012). The discussion on the exact criteria of SoC in BPD is ongoing. When a co-formulant is flagged as SoC, a risk assessment will be obligatory both via BPD and via REACH (duplication).

It is noteworthy that the Plant Protection Products Regulation (PPPR, 1107/2009/EC) and the Biocidal Product Directive (BPD, 98/8/EC, soon to be replaced by the Biocidal Products Regulation 528/2012/EC), deal only with the use of those products by professional workers (referred to as operators) and consumers. The standard requirements are high and independent of production levels and can be compared best to the requirements under REACH for substances produced or imported in amounts over 1,000 TPA. The exposure information, in particular, is more detailed than what is requested under REACH, possibly explaining why these uses are considered as being covered under the REACH regulation. Each directive or regulation requests a description of the hazard and the exposure of the substance itself and the formulation or matrix in which the substance is present.

In the product-specific legislation, there is no specific focus on the identification of emerging risks. However, compared with REACH, data demands are much higher with respect to toxicity, effectiveness of the product and dealing with

complaints, and perhaps the highest advantage is that all specific applications have to be evaluated, requiring a new authorization procedure. In this way, risks are assessed before the product and/or substance enters the market.

Cosmetics Directive

The Cosmetics Directive (76/768/EEC, replaced by Directive 1223/2009/EC from July 2013 onwards) deals with the safety of cosmetic products and their constituents. The Directive determines the list of substances that are prohibited in the composition of cosmetic products (Annex II) and the substances which are subject to restrictions or specific conditions of use (Annex III), for example "professional use only". The Directive also contains lists of authorized colourings (Annex IV), preservatives (Annex VI) and UV filters (Annex VII). There is a database containing information on commonly used or forbidden cosmetic ingredients, named CosIng (http://ec.europa.eu/consumers/sectors/cosmetics/cosing/index_en.htm, access date May 15th 2013). Cosmetics need to be notified according to Article 13 of Directive 1223/2009/EC, to which Member State competent authorities and poison centres have access.

The Cosmetics Directive requires that every cosmetic product placed on the market in Europe is safe to use. The manufacturer must ensure that cosmetic products undergo an expert scientific safety assessment before they are launched for sale. The Commission is advised by scientific committees on issues related to the safety and allergenic properties of cosmetic products and ingredients. The competent authorities in each Member State are in charge of reviewing the safety assessments and checking products already on the market. The testing of cosmetic products is carried out by national laboratories in accordance with the requirements set out in the analytical methods.

The free movement of cosmetic products within the European market cannot be restricted or prohibited by Member States if these products are not dangerous to human health under normal or foreseeable conditions of use. However, if a cosmetic product conforming to this Directive constitutes a danger to human health, the Member State in whose territory the product is marketed may take restrictive or prohibitive measures. In this instance, it informs the other Member States and the Commission so that appropriate measures can be taken throughout the European Union (EU). Member States are responsible for monitoring their market. To this end, they check the safety of products manufactured or imported in the EU. The Cosmetics Directive 76/768/EEC requires that Member States of the European Union ensure that the competent authorities 'cooperate in areas where such cooperation is necessary to the smooth application of this Directive'. Member States are responsible for the surveillance of their market. To that end, they should cooperate and exchange information, including information on serious undesirable effects that are attributable to the use of cosmetics.

It appears in the guidance document published by the Scientific Committee on Consumer Safety (SCCS) for conducting the safety assessment of the cosmetic ingredient for the relevant user population, including consumers (primary focus) and workers. The safety of the workers that make the cosmetic, the industrial workers, should be evaluated under REACH. This may, in practice, be 'forgotten', as some may think it is covered by the Cosmetics Directive. In any case, the safety of workers is subject to the worker safety Directives. In practice, due to different pieces of legislation and routes to follow, it may be difficult for

company doctors, occupational hygienists, or other safety assessors to obtain the relevant product information. It is noted that, under the Cosmetics Directive, manufacturers must keep and make available the product ingredients and safety dossier on the level of dangerous substances (classified substances).

Unique for cosmetics is the ban on animal testing for cosmetic products and their ingredients. Although this represents a desirable movement community-wide, unforeseen risks may result from the lack of toxicological information. As mentioned above, safety dossiers need to be prepared for dangerous substances, but the identification of these substances depends on results in animal testing. Currently, animal–testing-free classification is allowed only for skin irritation.

Pharmaceuticals

The safe use of substances in medicinal products is assessed under the legislation dedicated to medicinal products (Medicinal Products Directives for human products and veterinary products; Directive 2001/83/EC and 2011/82/EC), including medical equipment such as tubing, and is exempted from registration in REACH. However, the formulation process for medicinal products itself is not evaluated in the dedicated Directives, therefore the registration of the individual substances used in the formulation process is obligatory under REACH. The use of drugs by patients and the application of drugs by workers to patients are covered in the legislation for medicinal products and the worker safety Directive. One example of a risk to workers applying the drugs to patients is cytostatics, where advanced training is mandatory for workers who apply those drugs. However, such work conditions fall under the worker safety Directive. In the Medicinal Product Directives, there is an infrastructure to detect emerging risks, which indirectly may also protect the workers that make drugs or apply drugs to patients. The development of medicine goes through a number of phases, the pre-clinical phases (small scales at initial phases), clinical phase, and the market phase. In the clinical and in the market phase, a legal requirement for pharmacy companies consists of a follow-up of new drug use in patients by keeping records of any possible treatment or drug-related effects. In the Netherlands, Lareb (Netherlands Pharmacovigilance Centre) maintains a database on the possible side-effects of drugs on the market. Both health care workers and patients have the possibility to report the side-effects of the drugs they are using. This system allows the fast-tracking of emerging risks caused by drug use. Each phase, even late in the market phase, may result in withdrawal of the (newly developed) drug.

7 Examples of emerging risks

Emerging risks for workers can be identified via various information sources. In this section, an overview of emerging risks that were detected during the last decade is presented in Table 2. The list of examples of emerging risks is not exhaustive and may be updated based on new insights and additional information.

The examples were obtained from the Risk Watch (section 4.4), e-news and evaluation reports from NIOSH (section 4.5) and from the expert presentations in Modernet (section 4.6). They are mainly based on case reports, the clustering of effects and trend analyses. The causality between the substance, exposure and disease of the presented examples varies and has to be further investigated in many cases. After the detection of substances that may give rise to a health concern, these signals must be strengthened by a preliminary assessment of evidence. This is done by searching literature and databases to check whether the same substance has been reported before. The next step in the study of causality is the confirmation of the signal by specified research. If a substance is evaluated to be an emerging risk for human health, this information must be communicated to health and safety professionals, manufacturers/importers/users of the substance, the labour inspectorate and other stakeholders. It may also be necessary to initiate further research and/or take measures so that exposure and health risks are controlled.

Table 2. Examples of emerging risks.

Substance	**Worker population / tasks**	**Observed health effect**	**Emerging risk (reason of concern)**	**Organization**	**Literature**
Formaldehyde	Hairdressers - use of hair straightening products	Irritation skin, eyes and respiratory tract, allergies	Increased use of the products Illegal use (within the EU formaldehyde is not approved for use in hair straightening products)	Afssaps BfR US-OSHA NIOSH	BfR (2010), AFSSAPS (2010), NIOSH HHE (2011b)
Indium tin oxide	Manufacture of flat-panel displays (LCD, plasma screen)	Pulmonary fibrosis	New technology	NIOSH (inquiry based on case reports)	Homma et al. (2005), Cummings et al. (2010), NIOSH HHE (2012b)
Crystalline silica (sand)	Sandblasting of textiles	Silicosis	New use, intensified exposure	Atatürk University (Turkey) - investigation based on case reports	Akgun et al. (2005), Akgun et al. (2008)
Synthetic polymeric fibres	Textile workers from a nylon flocking plant	Interstitial lung disease (Flock worker's lung)	New risk	Memorial Hospital of Rhode Island - investigation based on case reports NIOSH	Lougheed et al. (1995), Kern et al. (1998), Eschenbacher et al. (1999), Kern et al. (2000)

Substance	Worker population / tasks	Observed health effect	Emerging risk (reason of concern)	Organization	Literature
Vinyl chloride	Hairdressers and barbers - use of hairspray	Angiosarcoma of the liver	Historical risk	3 universities in US (publication of case reports)	Infante et al. (2009)
Tricresyl phosphate	Pilots and cabin crew	'Aerotoxic syndrome' (neurological symptoms)	New exposure scenario	Universities US (case report), Occupational Health Services (evaluation physicians) Daily mail news item on case	Montgomery et al. (1977), Rayman et al. (1983), Tashkin et al. (1983), Sparks et al. (1990), Abou-Donia et al. (2013), Van Netten (1998), Winder et al. (2002), Winder (2006)
Diacetyl-containing flavourings	Workers in flavouring production facility and workers that apply flavours (microwave popcorn production facility, cookie factory, coffee processing facility)	Bronchiolitis obliterans	New risk	NIOSH alert	Kreiss et al. (2002) Akpinar-Elci et al. (2004) Kanwal et al. (2006) Cavalcanti Zdo et al. (2012) NIOSH Alert (2003) NIOSH HHE (2009a)

Substance	Worker population / tasks	Observed health effect	Emerging risk (reason of concern)	Organization	Literature
					CDC (2013) CDC (2002) Kreiss (2007) Kullman et al. (2005) Parmet et al. (2002) van Rooy et al. (2007)
Perchloroethylene	Dry cleaning	Oesophageal squamous cell carcinoma	Historical risk	Connolly Hospital, Dublin, Ireland (case report) Parliamentary questions in EU Parliament ECSA (product safety summary and health summary on perchloroethylene)	Babiker et al. (2012) ECSA (2011a) ECSA (2012a)

Substance	Worker population / tasks	Observed health effect	Emerging risk (reason of concern)	Organization	Literature
Dipentene and pine oil	Automobile mechanics - use of home-made hand washing paste	Contact dermatitis	New exposure scenario [allergic OCD risk in workplaces related to the use of home-made products]	University of Florence, Italy (case report)	D'Erme et al. (2012)
5-Aminosalicylic acid	Drug manufacturing	Occupational asthma	New risk	Biomedical research network centre on respiratory diseases, Madrid, Spain (case report)	Sastre et al. (2010)
Multiple pesticides, including those that contain well-known endocrine disruptors such as carbendazim, 2,4-dichlorophenoxyacetic acid, glyphosate, ioxynil, linuron, trifluralin and vinclozolin	Farmers	Birth defects (congenital malformations)	Intensified exposure (mixture of chemicals resulting in synergy) [Father: spraying without protection. Family: close contact to father, consumption of own products from garden, pigs and poultry. Pesticide levels unknown]	University of Caen, France (case report)	Mesnage et al. (2010)

Substance	Worker population / tasks	Observed health effect	Emerging risk (reason of concern)	Organization	Literature
Tropenol ester (intermediate during production of medicines)	Drug manufacturing - chemical-technical operative	Anticholinergic intoxication	New risk [accidental exposure]	University Medical Center of the Johannes Gutenberg University of Mainz, Germany (case report)	Muttray et al. (2012)
Disulfiram (used for treatment of alcoholism)	Artist - painting involving solvents such as ethanol, methanol, toluene, acetone etc.	Disulfiram alcohol reaction	New exposure scenario [adverse interaction between occupational solvent exposures and disulfiram]	Centre for Occupational and Environmental Health Research, University of Cape, South Africa (case report)	Ehrlich et al. (2012)
Hexamethylene diisocyanate	Paint quality controller	Acute life-threatening extrinsic allergic alveolitis (EAA)	New risk New route of exposure [Correlation of EAA with diisocyanate known, but with HDI is new. Dermal exposure not recognised before as significant route of exposure]	Bern University Hospital, Bern, Switzerland	Bieler et al. (2011)
Methylene diphenyl diisocyanate (MDI)	Orthopaedic plaster casts workers (plastic in plaster casts commonly	Occupational asthma	New risk level [exposure levels lower than OEL]	Finnish Institute of Occupational Health, Helsinki, Finland (case report)	Suojalehto et al. (2011)

Substance	Worker population / tasks	Observed health effect	Emerging risk (reason of concern)	Organization	Literature
	contain up to 25% MDI).				
Methylene bisphenyl diisocyanate (MDI)	Workers with spray-on truck bed liner applications	Occupational asthma, death	Increased use Exposure above safety limit [The spray-on bed liner industry is rapidly growing]	NIOSH alert (based on case studies)	NIOSH Alert (2006)
Triglycidyl isocyanurate	Powder paint sprayers – bystanders, Painter using powder paint	Occupational asthma, Extrinsic allergic alveolitis (EAA)	New exposure scenario [indirect exposure of bystanders] New effect (EAA was not a known effect until then)	Occupational Lung Disease Unit, Birmingham Heartlands Hospital, UK. Allergy Department, Fundación Jiménez Díaz Madrid, Spain	Anees et al. (2011) Quirce et al. (2004)

Substance	Worker population / tasks	Observed health effect	Emerging risk (reason of concern)	Organization	Literature
Tremolite-free chrysotile (= white asbestos)	Mill worker from a tremolite-free Canadian mine	Peritoneal mesothelioma	New risk [Tremolite contamination has been proposed as the cause of mesothelioma in workers exposed to commercial chrysotile. Study now shows that chrysotile without tremolite can cause peritoneal mesothelioma]	Brown University, US	Egilman et al. (2011)
Rhodium salts	Operator of an electroplating plant	Occupational asthma, rhinitis	New risk [Case report. Platinum salts are well known occupational allergens, rhodium salts have not been identified as inhalative sensitizing substances]	Research Institute of Occupational Medicine, Bochum, Germany	Merget et al. (2010)

Substance	Worker population / tasks	Observed health effect	Emerging risk (reason of concern)	Organization	Literature
Methyl-methacrylate	Student dental technicians polishing and grinding prostheses	Hypersensitivity pneumonitis (EAA)	New effect (EAA was not a known effect until then)	Clinique des Maladies Respiratoires Hôpital Calmette, Lille France	Scherpereel et al. (2004)
Ethyl methacrylate	Nail technician	Hypersensitivity pneumonitis (EAA)	New risk [Case report. Correlation with methyl methacrylate (MMA) is known; MMA has been substituted with ethyl and other methacrylates.]	RNV3P	OHSP (1997) Spencer et al. (1997) CIR Expert panel (2002)
Potassium aluminium tetrafluoride	Workers with potassium aluminium tetrafluoride, including aluminium industry	Bronchial hyperreactivity and occupational asthma, non-specific allergy reaction	New/increased risk [correlation asthma and fluorides is known but with potassium aluminium tetrafluoride (fluxes) not. Effects at lower concentrations than fluorides]	Department of Occupational and Environmental Medicine, Lund, Sweden	Hjortsberg (1999)

Substance	Worker population / tasks	Observed health effect	Emerging risk (reason of concern)	Organization	Literature
Trichloroethylene (TCE)	Industrial machinery repairer, industrial worker	Parkinson's Disease	New risk	The Parkinson's Institute, University of California, US (case-control study) ECSA (product safety summary and health summary on perchloroethylene)	Goldman et al. (2012) ECSA (2011b) ECSA (2012b)
Trichloroethylene (TCE)	Production of microporous polyethylene battery separator material for lead-acid battery applications - extruder, winder, rover, utility, pelletizer, cut-to-fit, and maintenance	Central nervous system effects, dementia	New exposure scenario [correlation of TCE and neurological effects known]	NIOSH health hazard evaluation	NIOSH HHE (2008)
Ultrafine particles	Office workers close to laser printer	Health effects including headaches, irritation	New source of exposure	Several research studies	He et al. (2007) Morawska et al. (2009) Lee et al. (2007)

Substance	Worker population / tasks	Observed health effect	Emerging risk (reason of concern)	Organization	Literature
Beryllium	Workers with beryllium-containing materials (various industries)	Sensitization, Chronic Beryllium Disease (lung disease)	New risk level, new type of exposure	NIOSH alert (based on case studies)	NIOSH Alert (2011)
Cleaning spray (including chlorine, bleach, disinfectants) - bleach, ammonia, decalcifiers, acids, solvents and stain removers	Professional cleaners	Occupational asthma	Increased use of sprays	Spanish and Danish research institutes Expert opinion, from the Centre for Research in Environmental Epidemiology in Barcelona	Nielsen et al. (1999) Zock et al. (2001) Medina-Ramon et al. (2005) Zock et al. (2007) Kirby (2010)
Lead	Employees at firing ranges	Nausea, diarrhoea, vomiting, poor appetite, weight loss, anaemia, excess lethargy or hyperactivity, headaches, abdominal pain, and kidney problems.	New exposure scenario [Although no symptoms typical for lead intoxication were observed, the lead concentrations were increased in air and blood, exceeding the OSHA PEL]	NIOSH alert (based on case studies)	NIOSH Alert (2009)

Substance	Worker population / tasks	Observed health effect	Emerging risk (reason of concern)	Organization	Literature
Trimethyl benzene	Workers at a drum refurbishing plant	Respiratory irritation, chemical burns, and headaches	New exposure scenario / insufficient protection [levels above OEL]	NIOSH health hazard evaluation	NIOSH HHE (2011a)
1-bromopropane (1-BP)	Dry cleaner	Light-headedness	New use (conversion from perchloroethylene to 1-BP). Insufficient protection	NIOSH health hazard evaluation	NIOSH HHE (2010)
Cobalt	Cemented tungsten carbide workers	Hard metal lung disease and occupational asthma	Insufficient protection / new exposure scenario [cobalt exposures exceeded the NIOSH REL and/or the OSHA PEL. Combination of cobalt with tungsten carbide is more potent than cobalt alone]	NIOSH health hazard evaluation	NIOSH HHE (2009b) Lison et al. (1995)
Epoxy resins, fragrances and thiazoles	Biocide and cosmetic exposures	Allergic contact dermatitis	Increased incidence	RNV3P	-

Substance	Worker population / tasks	Observed health effect	Emerging risk (reason of concern)	Organization	Literature
Ready-to-use mixtures of powdered plants extracts: henna, guar gum, indigo, diphenylenediamine, and different plant materials	Hairdressers	Occupational asthma	Re-emerging risk [known risk]	RNV3P	-
Pesticides – methyl bromide and phosphine residual gases (fumigation of containers)	Dock workers - opening of containers	Respiratory disorders, neurotoxic symptoms, mild acute health effects	New exposure scenario	BfR (expert meeting based on cases) Cases mentioned by NL expert (NCOD)	BfR (2007)
Trichloramine	Poultry processing employees and government food inspectors	Eye and respiratory irritation	Insufficient protection [effect of trichloramine in poultry processing unit already known. Trichloramine levels were below OEL. Effects may have been caused by other irritants]	NIOSH health hazard evaluation	NIOSH HHE (2012a)

Substance	**Worker population / tasks**	**Observed health effect**	**Emerging risk (reason of concern)**	**Organization**	**Literature**
Glyphosate	Unknown	Rhabdomyolysis (acute muscular wasting syndrome)	New risk [also cases showing a correlation of rhabdomyolysis and other pesticides (phenoxy acid herbicides and organophosphorous insecticides).		Meulenbelt et al. (1988) Bradberry et al. (2000) Weng et al. (2008)
Aerosolised ribavirin	Health care workers	Asthma	New risk	Respiratory Division, University of British Columbia, Vancouver, Canada Medical center and university in California, US	Dimich-Ward et al. (2004) Linn et al. (1995)
Metal fumes or dust	Metal workers	Amyotrophic Lateral Sclerosis	New risk [2 clusters of ALS in France; case-control study needed to confirm correlation]	Occupational & Environmental Diseases Centre, Grenoble, France	-

Substance	Worker population / tasks	Observed health effect	Emerging risk (reason of concern)	Organization	Literature
Epoxy resin	Epoxy resin applicator	Precancerous skin lesions	New risk [case study, further investigation required]	RNV3P / OD Centres	-
Fluorohydrocarbons	Refrigeration technician	Systemic scleroderma	New risk [1 case of systemic scleroderma. Possible correlation with fluorohydrocarbons, but further investigation required]	RNV3P	Bonneterre et al. (2010)
Chloracetal C5	Manufacturing vitamins and amino-acids	Renal cell cancer	New risk [case reports France, correlation is possible but not confirmed]	French Institute for Public Health surveillance (InVS)	-
Impregnation sprays for leather, impregnation spray containing fluorocarbons	Consumers spraying leather	Toxic alveolitis/ pneumonitis	New risk [case reports]	Academic Medical Centre, Amsterdam, VU Medical Centre, Amsterdam Sint Franciscus Gasthuis, Rotterdam	Smit AA (2004) Bonte et al. (2003)

Substance	Worker population / tasks	Observed health effect	Emerging risk (reason of concern)	Organization	Literature
Fluorocarbon	Workers of a horse rug cleaning firm spraying the fluorocarbon			Ninewells Hospital, Dundee, Scotland, UK Perth Royal Infirmary, Perth,Scotland, UK	Wallace et al. (2005)
bromochlorodifluoromethane (Halon 1211)	Workers using a fire extinguisher	Reactive Airways Dysfunction Syndrome (RADS)	New risk [case reports]	CHI and INSERM Créteil, France AIMTRSP, Chevilly Larue, France	Matrat et al. (2004)
Fibreglass with styrene resins	Yacht builders/ Work with glass reinforced plastics	Bronchiolitis obliterans	New risk	Hospitals and research centres in UK, USA and Taiwan	Cullinan et al. (2013)

8 Recommendations

The main objective of this study is to demonstrate the need for a system that is able to identify chemicals that cause health problems which have not yet been identified as soon as possible. The list of examples of emerging risks presented in Chapter 7 demonstrates that workers are still suffering from health impairment through exposure to chemicals at work despite all regulations. This knowledge stresses the need to monitor emerging risks continuously so that legislation and/or rules can be adjusted or developed to handle the situation. In some instances, increased enforcement may be needed to control the health risk.

The identification of emerging risks is a worldwide task. A network of occupational disease professionals and scientists was founded to identify and analyse emerging risks (Modernet). The individual Modernet members present cases and studies that will be discussed during the meetings. So the Modernet output depends on the activity of its members.

In the Netherlands there is currently no structure for identifying emerging risks. Because of the '*risque social*' security system, there is no incentive to investigate possible causal relationships between chemical exposure and health effects. There are no databases available for data mining and, until recently, professionals could not report emerging risks to an official authority. In July 2013, the Netherlands Centre for Occupational Disease launched SIGNAAL, which is an e-tool for occupational physicians to report health problems that might be due to exposure to substances and which could turn out to be emerging risks. It is of utmost importance for the Netherlands to be active in Modernet. Only by combining all activities of the individual members, can the identification and analysis of emerging risks be performed in a cost-effective way.

As discussed in chapter 3, the identification of emerging risks requires several complementary methods. The most informative methods are:

- The collection of case reports and their subsequent analysis by setting up a Dutch group of experts; set up by RIVM and NCOD;
- Periodic screening of literature and important websites by RIVM and NCOD;
- Analysis of databases comprising information on health effects, exposure and occupation in cooperation with Modernet.

To be able to implement these methods, it is necessary to:

- Create a system in the Netherlands in which emerging risks can be reported by occupational physicians and others such as GPs, medical specialists and possibly workers themselves. Since July 2013, physicians have been able to report emerging risks using SIGNAAL. This e-tool should be brought to the attention of all occupational physicians and extended to other interested parties;
- Periodic literature searches, conducted by RIVM and NCOD, of both published literature and important websites using text mining techniques, so that Table 2 (examples of emerging risks) is updated continuously;
- Analyse databases with information on occupational health effects and exposure both for hypothesis generation and case finding using data mining

techniques. Since the Netherlands does not have such a database, it is of utmost importance to work together in the MODERNET network;
- Create a national expert group of occupational physicians, medical specialists, epidemiologists and industrial hygienists to study cases and clusters. After signal detection, the expert group should check whether the signal is real (signal strengthening) and whether additional research is necessary to confirm the signal. The National expert group will be set up by RIVM and NCOD and should work together with specialists from other countries using MODERNET;
- Discuss cases and clusters within the MODERNET network to guarantee European uniformity regarding the scientific evaluation. Within the MODERNET network, signals gathered by all participating countries will be discussed and disseminated;
- Disseminate knowledge and information about emerging risks by using national and international organizations and networks (see Table 1) to inform professionals, manufacturers/importers/users of the substance, the labour inspectorate and other stakeholders in the field as soon as possible so that actions can be taken to prevent further damage to human health;
- Consult Bureau REACH of RIVM to check how a chemical is regulated and enforced, so that appropriate action can be taken:
  - If workers fall ill at exposures lower than its occupational exposure limit (OEL) or derived no-effect level (DNEL), these limits must be re-evaluated. The Dutch Health Council, SCOEL and/or ECHA shall be informed in that case;
  - If workers are exposed at concentrations that are too high (higher than the public or private OEL) and enforcement is a problem, the labour inspectorate should be informed so that measures can be taken;
  - If unknown toxic effects or new ways of exposure to a substance arise, it should be decided which actions should be taken to further regulate the substance. Possible actions might be a thorough risk evaluation of the substance by the registrant via the substance evaluation pathway in REACH. In the case of specific substance groups, other organizations should take the lead (e.g. regarding plant protection products or biocides, the Board for the Authorization of Plant Protection Products and Biocides (Ctgb))

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Annex 1: Organizations that might detect emerging risks

Country / continent	Organization	Description	Reference
NL	Arbouw	Initiative of worker and employer organizations to improve the working conditions in the construction industry.	http://www.arbouw.nl/
NL	Bureau Beroepsziekten FNV	Policlinic for occupational respiratory and dermal disorders	http://www.fnv.nl/publiek/lidmaatschap/bureau_beroepsziekten_fnv/
NL	CALHAR	Outpatient clinic for work-related respiratory and dermal diseases; department of the Erasmus medical centre	http://www.erasmusmc.nl/dermatologie/patientenzorg/info-calhar/
NL	Centrum voor huid en arbeid (Velp)	Centre of knowledge and advice on occupational dermal diseases	http://www.huidenarbeid.nl/
NL	Coronel institute	Institute for occupation and health; department of the Academic Medical Center (AMC)	http://www.amc.nl/web/Het-AMC/Afdelingen/Overzicht/Coronel-Instituut-voor-Arbeid-en-Gezondheid/Coronel-Instituut-voor-Arbeid-en-Gezondheid/Instituut.htm
NL	Gezondheidsraad	Dutch Health Council, independent scientific advisory body	http://www.gezondheidsraad.nl
NL	GGD	Community Health Services	http://www.ggd.nl/
NL	ILT	The Human Environment and Transport Inspectorate	http://www.ilent.nl/
NL	KIP-MG	Knowledge and information network for environment and human health	http://kennisnetmilieuengezondheid.nl/
NL	NCOD	The Netherlands Centre for Occupational Diseases	http://www.beroepsziekten.nl/content/ncvb
NL	NECOD	Netherlands Expert Centre of Occupational Skin Diseases	http://www.necod.nl/

Country / continent	Organization	Description	Reference
NL	NKAL	Netherlands Expert Centre of Occupational Skin Diseases Expertise Centre for Occupational Respiratory Disorders	http://www.nkal.nl/
NL	NVAB	The Netherlands Society of Occupational Medicine	http://nvab.artsennet.nl/Nieuws-20.htm
NL	NVIC	National Intoxication Information Centre	https://www.vergiftigingen.info/home.htm
NL	Tox-poli	Outpatient clinic for occupational toxicology	http://www.ects.nl/Gezondheidsmonitoring/Polikliniek_klinische_arbeidstoxicologie
NL	VNCI	The Association of the Dutch Chemical Industry	http://www.vnci.nl/
BE	Clinic for occupational and environmental medicine	Part of University Hospitals Leuven	-
DE	BAuA	Federal Institute for Occupational Safety and Health	http://www.baua.de/en/Homepage.html
DE	BfR	Federal Institute for Risk Assessment	http://www.bfr.bund.de/de/start.html
DE	DGUV / IPA / IFA	DGUV: German Social Accident Insurance IFA: institute for research and testing of the DGUV IPA: research institute for prevention and occupational medicine of the DGUV	http://www.dguv.de/content/index.jsp http://www.dguv.de/ifa/de/index.jsp# http://www.ipa.ruhr-uni-bochum.de/e/forschung/index.php
FR	ANSES	French Agency for Food, Environmental and Occupational Health & Safety	http://www.anses.fr/en
UK	BOHS	British Occupational Hygiene Society	http://www.bohs.org/

Country / continent	Organization	Description	Reference
UK	Centre for Occupational and Environmental Health	The centre engages in research and education. It investigates the relationship between the environment and human health with special reference to occupation and other environmental factors; part of the University of Manchester	http://www.medicine.manchester.ac.uk/oeh/
DK	EPA	Danish EPA	http://www.mst.dk/English/
FI	FIOH	Finnish Institute of Occupational Health	http://www.ttl.fi/en/safety/occupational_health_safety/Pages/default.aspx
NO	NIOH	National Institute of Occupational Health	http://www.balticseaosh.net/
SE	KEMI	Swedish Chemicals Agency	http://www.kemi.se/en/
N-EU	BSN	The Baltic Sea Network on Occupational Health and Safety (BSN). Expert network	http://www.balticseaosh.net/
IT	INAIL	National Institute for Insurance of Occupational Accidents and Occupational Diseases	http://www.inail.it/Portale/appmanager/portale/desktop?_nfpb=true&_pageLabel=PAGE_HOME_EN
EU	CEFIC	The European Chemical Industry Council	http://www.cefic.org/
EU	COST-MODERNET	Monitoring trends in Occupational Diseases and tracing new and Emerging Risks in a NETwork	http://www.costmodernet.org/
EU	EAPCCT	European Association of Poisons Centres and Clinical Toxicologists	http://www.eapcct.org/index.php?page=aims
EU	ECHA	European Chemicals Agency	http://echa.europa.eu/web/guest/home
EU	ERO	European Risk Observatory	http://osha.europa.eu/en/riskobservatory/index_html
EU	JRC	Joint Research Centre	http://ec.europa.eu/dgs/jrc/index.cfm
EU	NEW OSH-ERA	The NEW OSH ERA project helped to combine the strengths of the different EU Member States in occupational safety and health (OSH) research. Funded within ERA-NET	http://www.newoshera.eu/en/index_html
EU	OECD	OECD	www.oecd.org

Country / continent	Organization	Description	Reference
EU	OSHA-EU	European agency for safety and health at work	http://osha.europa.eu/nl/front-page
EU	PEROSH	Partnership for European Research in Occupational Safety and Health	http://www.perosh.eu/p/MM00-01
EU	SCENIHR	Scientific Committee on Emerging and Newly Identified Health Risks	http://ec.europa.eu/health/scientific_committees/emerging/index_en.htm
US	NIH	The National Institutes of Health; a part of the U.S. Department of Health and Human Services External Web Site Policy	http://www.nih.gov/
US	IOSG	Institution of Occupational Safety and Health	http://www.iosh.co.uk/
US	OSHA	Occupational Safety and Health Administration	http://www.osha.gov/
US	NIOSH	NIOSH (National Institute for Occupational Safety and Health), part of the Centers for Disease Control and prevention (CDC)	http://www.cdc.gov/niosh/
US	Risk Science Center	Interdisciplinary research center dedicated to supporting science-informed decision-making on existing and emerging human health risks that is responsive to today's rapidly changing social, economic and political global landscape; part of the University of Michigan	http://www.sph.umich.edu/riskcenter/
US	AAPCC	American Association of Poison Control Centers	http://www.aapcc.org/
International	ICOH	International Commission on Occupational Health	http://www.icohweb.org/site_new/ico_about.asp
International	ICPS	International Programme on Chemical Safety, part of the World Health Organization (WHO)	http://www.who.int/ipcs/en/
International	ILO	International Labour Organisation	http://www.ilo.org/global/lang--en/index.htm
International	IOHA	International occupational hygiene association	http://www.ioha.net/

Country / continent	Organization	Description	Reference
International	IRGC	International Risk Governance Council; aims to help improve the understanding and management of potentially global risks that have impacts on human health and safety, the environment, the economy and society at large. IRGC focuses in particular on emerging, systemic risks for which governance deficits exist.	http://www.irgc.org/
International	SCOM	Scientific Committee on Occupational Medicine of the International Commission on Occupational Health (ICOH)	http://www.icohweb.org/site_new/ico_scientific_committee_detail.asp?sc=42
International	SRA	Society for Risk Analysis (SRA)	http://www.sra.org/index.php
International	WHO collaborating centres network	WHO Collaborating Centre for Occupational Health	http://www.who.int/occupational_health/network/en/

Annex 2: Sources for detection of emerging risks

Country / continent	**Database**	***Organization***	**Objective**	**Information source**	**Reference**
NL	News service	*Chemical Watch*	Provides information needed to manage the risks of chemicals responsibly. Chemical Watch publishes news and intelligence to help companies meet responsibilities under chemicals legislation worldwide, including regimes such as REACH, CLP, GHS and TSCA.	Publications	http://www.chemicalwatch.com/
NL	SIGNAAL	*NCOD*	Registration and signalling of occupational diseases	Physicians	https://www.signaal.info
NL	ERDSS	*RIKILT – WUR*	Emerging Risks Detection Support System (ERDSS). Development of an 'early warning' system to predict emerging risks in the food chain		http://www.wageningenur.nl/nl/Expertises-Dienstverlening/Onderzoeksinstituten/rikilt/Onderzoek/Nieuwe-risicos.htm
NL	Nieuws bulletin	*Aw-ChemAdvice*	Weekly news bulletin on chemicals related subjects	Publications	
UK	THOR	*University of Manchester*	The Health and Occupation Research Network. THOR functions as a 'observatory' for medically certified information on incidence, trends and sickness absence burden of occupational disease and work-related ill health, at a national and regional level, and within specific industrial sectors.	Medical specialists	http://www.medicine.manchester.ac.uk/oeh/research/thor/ http://www.hse.gov.uk/statistics/sources.htm

Country / continent	**Database**	***Organization***	**Objective**	**Information source**	**Reference**
UK	THOR-Extra	*University of Manchester*	The main purpose of THOR-Extra is to give physicians who report to THOR the option of reporting a case which you believe may be attributed to a novel or interesting cause.	Medical specialists	http://www.medicine.manchester.ac.uk/oeh/research/thor/schemes/thorextra
UK	SWI	*Self-reported work related illness survey*	Overview of work-related illnesses reported by employees. Part of the 'Labour Force Survey' (LFS)	Employees	http://www.hse.gov.uk/statistics/lfs/index.htm
UK	ODIN	*Occupational disease intelligence network*	Network between worker health surveillance systems in the UK	Medical specialists, physicians	Turner et al. (2005) Occup Med; 55(4): 275-81
FR	RNV3P	*ANSES*	The National Network for Monitoring and Prevention of Occupational Diseases. National network of experts listing all occupational health problems during consultations of occupational diseases at the University Hospital Centre (CHU) in a systematic and standardized manner.	National network of experts from occupational disease centres and health services	Bonneterre *et al*. (2010). Bonneterre *et al*. (2008) Sante Publique; 20 Suppl 3: S201-10. Bonneterre *et al*. (2008) Occup. Environ Med; 65(1): 32-7. http://www.afsset.fr/index.php?pageid=1671&parentid=943
SE	ISA	*Work Environment Authority*	The Swedish Information System on Occupational Accidents and Work-related diseases	Reports from employers about occupational accidents and diseases to the Social Insurance Agency	ISA, The Swedish Information System on Occupational Accidents and Work-related diseases (Report, 2005)

Country / continent	Database	*Organization*	Objective	Information source	Reference
NO	NOA	*NIOH*	National Surveillance System for Work Environment and Occupational Health (NOA). Data collection by surveys, patients from occupational medicine departments	Employees	http://www.stami.no/noa8
FI	FROD	*FIOH*	Finnish Institute of Occupational Health's Register of Occupational Diseases (FROD)	Physicians	http://www.ttl.fi/en/health/occupational_diseases/2005%20statistics/pages/default.aspx
CZ	Czech National Registry of Occupational Diseases	*National Institute of Public Health (NIPH)*	Health care establishment for basic preventive disciplines - hygiene, epidemiology, microbiology and occupational medicine. Statistics on occupational diseases in Czech Republic (1996-2011) available.	Specialists in occupational diseases	http://www.szu.cz Urban *et al*. (2002) Cent Eur J Public Health: 8(4): 210-2. Fenclova *et al*. (2009) Ind Health.; 47(4):443-8.
IT	-	*INAIL*	Database based on claims of occupational diseases and occupational accidents.		http://www.inail.it/Portale/appmanager/portale/desktop
EU	EODS	*European Commission*	European Occupational Diseases Statistics		http://ec.europa.eu/social/main.jsp?catId=787&langId=en
AU	SABRE	*Monash University*	Surveillance of Australian Workplace Based Respiratory Events	Respiratory and occupational physicians	http://www.coeh.monash.org/sabre.html

Country / continent	**Database**	***Organization***	**Objective**	**Information source**	**Reference**
CA	GPHIN	*Public Health Agency of Canada*	Global Public Health Intelligence Network. Public health surveillance, early-warning system that gathers preliminary reports of public health significance.	Media sources	http://www.phac-aspc.gc.ca/gphin/
US	Haz-Map	*NIH*	Occupational health database designed for health and safety professionals and for consumers seeking information about the adverse effects of workplace exposures to chemical and biological agents.	Textbooks, journal articles, the Documentation of the Threshold Limit Values (published by ACGIH), and electronic databases	http://hazmap.nlm.nih.gov/index.php

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