European Agency for Safety and Health at Work

ISSN: 1831-9343

# Methodologies to identify work-related diseases: Review of sentinel and alert approaches

## European Risk Observatory
## Literature Review

European Agency for Safety and Health at Work

Authors: Jelena Bakusic, Annet Lenderink, Charlotte Lambreghts, Sofie Vandenbroeck, Jos Verbeek, Stefania Curti, Stefano Mattioli, Lode Godderis

Project Management: Emmanuelle Brun, Elke Schneider, EU-OSHA

This report was commissioned by the European Agency for Safety and Health at Work (EU-OSHA). Its contents, including any opinions and/or conclusions expressed, are those of the author(s) alone and do not necessarily reflect the views of EU-OSHA.



More information on the European Union is available on the Internet (http://europa.eu).

Cataloguing data can be found on the cover of this publication.

Luxembourg: Publications Office of the European Union, 2017

ISBN: 978-92-9496-404-5

doi:10.2802/053155

# Table of contents

List of figures and tables ..... 4
Executive summary ..... 5
1 Introduction ..... 15
1.1 The burden of work-related diseases ..... 15
1.2 Definitions and typology of new work-related diseases ..... 16
1.3 Monitoring new work-related diseases ..... 17
1.4 Objective and research questions ..... 18
2 Methodology ..... 20
2.1 Review of scientific literature ..... 20
2.2 Grey literature review ..... 20
2.3 Selection of studies ..... 20
2.4 Data extraction and management ..... 22
2.5 Clarification of concepts ..... 22
3 Results ..... 29
3.1 Identification and basic typology of systems ..... 29
3.2 Availability of data and selection of systems ..... 35
3.3 Validation and collection of missing information ..... 41
4 Compensation-based national systems ..... 42
4.1 Main characteristics ..... 42
4.2 Report mechanism and data collection ..... 45
4.3 Evaluation of work-relatedness and use of data ..... 49
5 Non-compensation-related systems for data collection and statistics ..... 53
5.1 Main characteristics ..... 54
5.2 Reporting mechanism and data collection ..... 62
5.3 Evaluation of work-relatedness and use of data ..... 71
6 Sentinel systems ..... 79
6.2 Reporting mechanism and data collection ..... 86
6.3 Evaluation of work-relatedness and use of data ..... 89
7 Public health surveillance aimed at workers and non-workers ..... 96
7.1 Main characteristics ..... 97
7.2 Reporting mechanism and data collection ..... 98
7.3 Evaluation of work-relatedness and use of data ..... 100
8 Conclusions and recommendations ..... 103
8.1 Integrating different approaches to detect new/emerging WRDs ..... 103
8.2 Comprehensive data collection and coverage ..... 104
8.3 Linking data on exposure and health effects monitoring ..... 106
8.4 Exchange of information and better link with prevention ..... 108

8.5 Role of the present review in the overall project ..... 110
9 Appendix A — Search protocol ..... 111
10 Appendix B — Long list of identified surveillance systems ..... 121
11 Appendix C — Table of system codes ..... 154
12 References ..... 155
13 List of abbreviations ..... 160

# List of figures and tables

Table 1: Algorithm for classification of surveillance systems ..... 6
Table 2: Categories and examples of new work-related diseases ..... 16
Table 3: Algorithm for classification of systems ..... 29
Table 4: Typology of all identified 75 systems (see Table 5 for list of systems belonging to each code) ..... 30
Table 5: List of systems belonging to code categories defined in Table 4 ..... 31
Table 6: List of 25 systems excluded from the report ..... 36
Table 7: Typology of 50 systems described in report ..... 37
Table 8: Main characteristics of nine selected compensation-based systems ..... 44
Table 9: Reporting and data collection in nine selected compensation-based systems ..... 45
Table 10: Evaluation of work relatedness and use of data in compensation-based systems ..... 49
Table 11: Main characteristics of non-compensation-related systems primarily designed for data collection and statistics ..... 55
Table 12: Reporting and data collection in non-compensation-related systems primarily designed for data collection and statistics ..... 63
Table 13: Evaluation of work-relatedness and use of data in non-compensation-related systems primarily designed for data collection and statistics ..... 72
Table 14: Main characteristics of sentinel systems ..... 81
Table 15: Reporting and data collection in sentinel systems ..... 86
Table 16: Evaluation of new/emerging risks and use of data in sentinel systems ..... 90
Table 17: Main characteristics of public health surveillance systems ..... 97
Table 18: Reporting and data collection in public health surveillance systems ..... 99
Table 19: Evaluation of work-relatedness and use of data in public health surveillance systems ..... 101

Figure 1: Typology of systems described in the report ..... 7
Figure 2: PRISMA flow chart ..... 21

# Executive summary

Occupational factors play a significant role in the global burden of disease. In addition, rapid changes in working conditions may give rise to new occupational health risks and work-related diseases (WRDs).

Monitoring these new WRDs is essential from the perspective of early recognition and prevention. However, detecting new work-related risks and diseases may require additional instruments to those already used for monitoring known occupational diseases (ODs). Furthermore, it is not possible to detect new WRDs using a single method. A comprehensive approach is required, one that uses several complementary methods.

The current report is the main deliverable of Task 1 of the European Agency for Safety and Health at Work (EU-OSHA)'s 'Methodologies to identify work-related diseases — Review of sentinel and alert approaches' project. The overall objective of this project is to describe a number of approaches that have been taken to try to identify emerging health problems at work and WRDs. The main objective of this review is to provide insight into approaches to identify emerging WRDs and to complement the official figures of notified, recognised and compensated occupational diseases, which are usually the only comparative sources of information on the extent of health problems encountered at work. The aim of the report is to establish which systems and approaches are suitable for identifying new/emerging WRDs. Follow-up tasks to this review will seek to provide in-depth information on systems selected based on this review, through expert interviews and interactive discussions with and between systems' developers.

The following research questions were addressed in this review.

1. What existing occupational safety and health (OSH) alert and sentinel systems can detect new/emerging WRDs?
2. What are the main characteristics of these systems?
3. What is the basic typology of these systems?

### *Methodology*

An extensive scientific literature search was conducted, which combined terms for the following three concepts: (1) surveillance/reporting systems; (2) occupational/work-related diseases; and (3) new/emerging risks. In addition, a grey literature search was performed of both grey literature databases and relevant EU and research institute websites for additional resources. The authors of the relevant references were also contacted to obtain missing information and review the retrieved data.

### *Results*

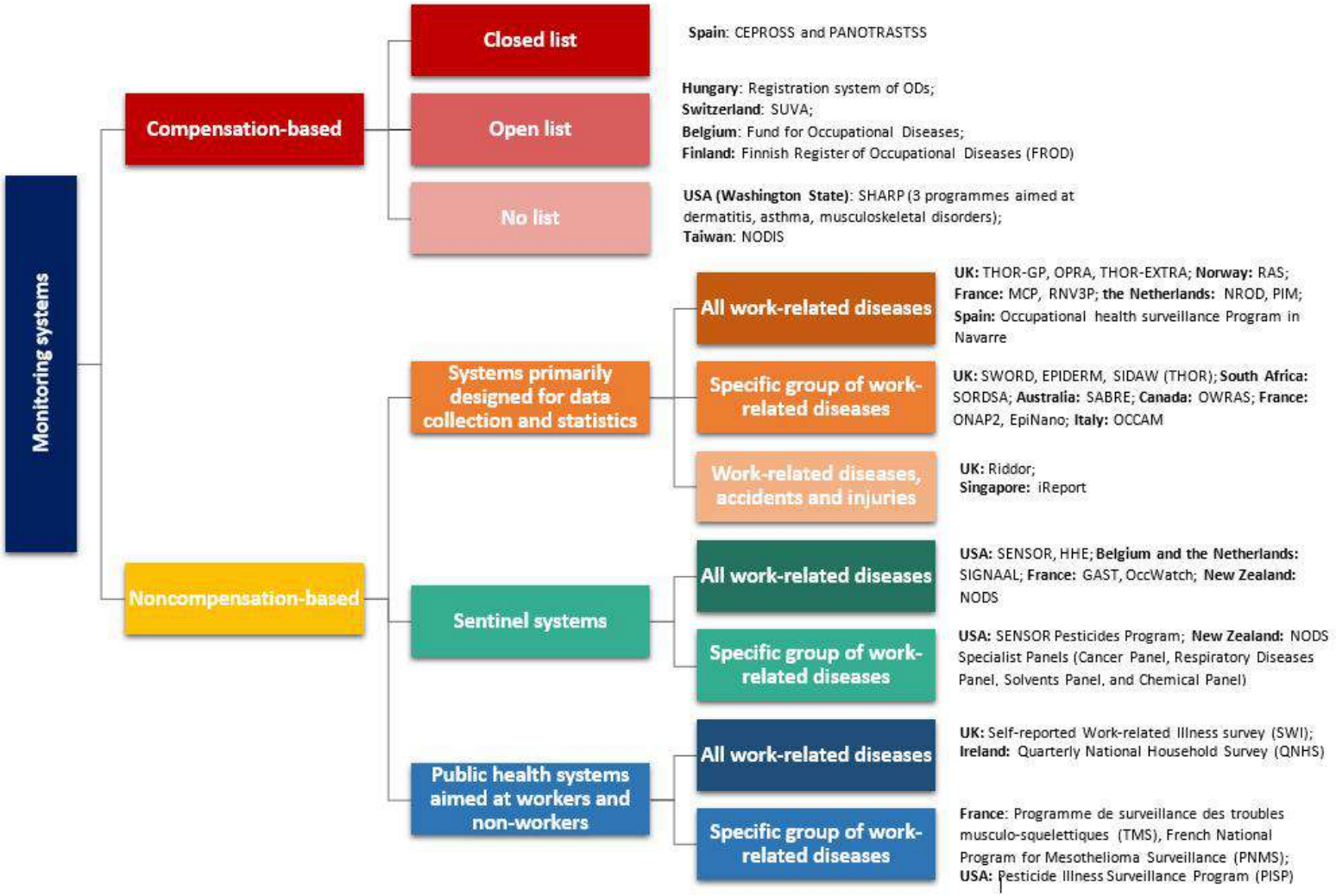
A total of 75 surveillance systems covering 26 different countries were identified, and 50 of these systems were analysed and described in this report. We developed an algorithm to classify the systems into different types, and addressed the questions in Table 1.

**Table 1: Algorithm for classification of surveillance systems**

| No | Question | Answers |
|---|---|---|
| 1 | Is the system aimed at workers or at the general public? | Workers/general public including workers |
| 2 | What type of surveillance does the system use? | Passive/active/sentinel |
| 3 | Is the system linked to workers' compensation?<br>If yes, what type of system? | Yes/no<br>Only list/list and complementary/no list at all |
| 4 | Which diseases or health problems are reported? | General (all diseases)/specific (one or subset of diseases) |
| 5 | Does the system also warn of new/emerging work-related health problems? | Yes/no |

We set up a basic typology of these systems by dividing them into four main groups: compensation-based systems (n=22), non-compensation-related systems primarily designed for data collection and statistics (n=34), sentinel systems (n=12), and public health surveillance systems covering workers and non-workers (n=7). These systems further differed in types of WRD monitored, coverage, data collection, mechanism of investigation of work-relatedness, follow-up of new/emerging risks, and link with prevention, etc. Typology of the systems is summarised in Figure 1.

**Figure 1: Typology of systems described in the report**



### *Compensation-based national systems*

Twenty-two compensation-based national systems (coded 1; see Appendix C) were identified in the initial long list (Appendix B). These 22 systems, linked to a workers' compensation system, included five systems with a prescribed list of ODs that could be reported for compensation (coded 1A); 11 systems with a list of ODs but also a complementary open list in which proof of the work-relatedness of the disease was required (coded 1B); and six systems in which a claim could be filed without a prescribed list (coded 1C). The systems coded 1B and 1C were also suitable for identifying new/emerging work-related health problems. In the present report, nine representative examples from this group are described, focusing on systems that, in addition to providing compensation, are interesting from the perspective of new/emerging WRDs. These systems covered both European countries (Belgium, Finland, Hungary, Spain and Switzerland) and two countries outside the EU (Taiwan and the United States of America (USA) — Washington state). Systems from this group mainly collected data for compensation purposes. However, some of them (Swiss and Taiwanese systems) provided an additional dataset that was unrelated to compensation, but could initiate the compensation process of reported cases, if relevant. The Washington Safety & Health Assessment & Research for Prevention (SHARP) programme derived all information through data mining in the Washington Workers' Compensation claims. As a general rule, self-employed workers were excluded from the monitoring schemes. All systems were gender-inclusive and some of them (in the European countries) covered small and medium-sized enterprises (SMEs). Cases were predominantly reported by physicians, but some systems allowed employers, employees and trade union delegates, etc. to make claims. Reporting was legally required for all systems from the European countries in this group, which was not the case for the systems from outside the EU (Taiwan and Washington). In all the systems, the work-relatedness of the cases was evaluated by the recognised authority (e.g. medical doctors from insurance funds, occupational physicians), and suspected cases of new/emerging WRDs were further investigated by experts. Reports were a common means of knowledge dissemination with a weak link to workplace preventive actions.

### *Non-compensation-related systems primarily designed for data collection and statistics*

Thirty-four non-compensation-related systems primarily designed for data collection and statistics were identified in the long list (Appendix B). Of these 34 (coded 2), 14 systems were aimed at all work-related or occupational diseases (coded 2A), of which three additionally also aimed to identify new/emerging work-related health problems (2A+). Eighteen non-compensation systems focused on one or a subset of work-related or occupational diseases (coded 2B) and two non-compensation systems on work-related injuries, accidents and diseases (coded 2C). Using the exclusion criteria specified in Section 3.2, 26 representative systems were selected and are further described in this report. This category of systems covers a large number of EU countries (the United Kingdom, Ireland, Italy, Norway, France, the Netherlands and Spain) and several non-EU countries (South Africa, Australia, Canada and Singapore). A common feature of these systems is that they were designed with the aim of improving

the collection and analysis of data to measure trends in work-related and occupational diseases. Among the systems for monitoring specific groups of WRDs, the majority were designed to collect information on work-related respiratory diseases. In addition, schemes for monitoring work-related skin diseases, occupational cancer, work-related infectious diseases and WRDs related to exposure to nanomaterials were identified. Some systems use other approaches in addition to physician reporting for collecting data, for example the French National occupational illness surveillance and prevention network (RNV3P) and the Italian OCcupational CAncer Monitoring (OCCAM) programmes perform data mining, whereas the French Registry Of Workers Handling Engineered Nanomaterials (EpiNano) project forms prospective cohort studies that include workers exposed to nanomaterials. In terms of the evaluation of work-relatedness, two different approaches were identified. One group of systems relies on the decision made by the reporting physician, and investigates no further (mostly systems from the 2B group for monitoring work-related respiratory diseases). In addition, these systems do not provide a follow-up of suspected cases of new/emerging WRDs. In the second approach used in other systems, the final decision on work-relatedness is made by the experts in the acknowledged authority (usually the research centre maintaining the system). International papers, symposia and websites are the usual means of disseminating the information and knowledge gathered by the systems. In addition, the French RNV3P provides several levels of dissemination, including internal alerts to clinicians in the RNV3P network, searches for similar cases outside the network and diffusion to authorities for necessary actions. In most other cases, links with prevention are weak, with a need for improvement.

### *Sentinel systems*

Monitoring systems in the sentinel group are specifically designed to provide a signal that will initiate interventions and prevention. Of the 12 identified sentinel surveillance systems, six focus on all work-related or occupational diseases (coded 3A), of which four additionally also aim to identify new/emerging work-related health problems (3A+). Six systems focus on one or a subset of work-related or occupational diseases (coded 3B). Eleven sentinel systems are described in the current report. The systems identified in this group have been implemented in few EU countries (Belgium, the Netherlands and Modernet countries (Modernet is an international network for monitoring occupational diseases and new emerging risks)) and in the USA and New Zealand. Two international systems were also identified in this group: the Signalling new occupational disorders (SIGNAAL) programme, initiated by occupational health physicians and experts in the Netherlands and Belgium, and the Occupational Diseases Sentinel Clinical Watch System (OccWatch) programme, designed by specialists from Modernet and currently hosted by the French Agency for Food, Environmental and Occupational Health & Safety (ANSES). All systems cover both genders and SMEs. In terms of disease coverage, most of the systems have a broad scope and aim to monitor all WRDs and ODs. However, despite being initially designed to monitor a wide range of WRDs, the US-based Sentinel Event Notification System for Occupational Risks (SENSOR) programme eventually reduced its focus to the Pesticide Monitoring Scheme, which remained the only active programme derived from SENSOR. Similarly, New Zealand's Notifiable Occupational Disease System (NODS) had several specialist panels for specific WRDs

(cancer, chemicals, solvents, and respiratory diseases), but only one of these has remained active (the Respiratory Diseases Panel). The reporting of cases is based on the voluntary participation of the reporters, mainly occupational physicians. As regards data collection, these systems are characterised by a more detailed exposure assessment (in comparison with other groups), which includes a more thorough description during reporting and possible workplace inspections as part of data gathering. In the specialist panels of the New Zealand NODS, additional data are collected by reviewing cases notified by registries such as the Cancer Register, the Asbestos Disease Register, the Asbestos Exposure Register, etc. Moreover, work-relatedness is evaluated with a high level of expertise; some of the systems have a team of experts on new/emerging WRDs. In the two international systems (SIGNAAL and OccWatch), evaluation is performed by specialists from different countries. In addition to the common means of disseminating data, such as case reports, international conferences, websites, etc., these systems have a strong link with workplace prevention, which is one of their main strengths. Preventive actions include a wide range of activities, such as direct workplace interventions aimed at protecting co-workers or removing workplace risk factors, and different forms of primary and secondary prevention. In all systems, cases are collected in a database that is seldom available to the public. In the cases of SIGNAAL and OccWatch, the online database provides a platform for discussions between experts, which may lead to the identification of similar cases.

### *Public health surveillance aimed at workers and non-workers*

Seven surveillance systems that are aimed at both workers and the general population were identified. Although these systems differ in design (two are survey based whereas the other five have a 'classic' surveillance system form), the main common feature is the extent of coverage, which includes both workers and the general population. Two of the systems present a module of nationwide surveys and are based on principles of active surveillance: the Self-reported Work Related Illness survey (SWI) in the United Kingdom and the Quarterly National Household Survey (QNHS) in Ireland. The main scope of these surveys is to estimate the incidence and prevalence of WRDs. Data collection is performed in three-month periods, through interviews with workers (randomly selected). During these interviews, workers can report any work-related health problems. In addition, these two systems aim to monitor all work-related or occupational diseases (coded 4A), whereas the other five are aimed at one or a subset of work-related or occupational diseases (coded 4B), such as musculoskeletal disorders, pleural mesothelioma and diseases related to pesticide exposure. The UK SWI and the Irish QNHS do not provide further evaluation of work-relatedness, in contrast to the disease-specific surveillance systems (4B), in which the evaluation of work-relatedness is carried out by authorised experts. All systems collect reported information in a database. The US Pesticide Illness Surveillance Program (PISP) database provides the means to identify high-risk situations warranting further action and implementation of additional restrictions on pesticide use.

## *Conclusions and recommendations*

### Integrating different approaches to detect new/emerging WRDs

The literature review shows that several types of surveillance systems can detect new/emerging WRDs. Some of these systems are primarily designed for compensation-based purposes but generate useful information for the detection of new/emerging WRDs (Group 1); others are non-compensation-based monitoring systems primarily designed for data collection and statistics (Group 2); and several systems are based on the sentinel approach (Group 3). In addition, we identified a group of systems that aim to monitor the work-related health of the general population, including workers (Group 4).

When it comes to detecting new/emerging WRDs, sentinel systems (Group 3) seem to be the most suitable approach. Following the sentinel health event (SHE) model (Rutstein et al., 1983), a suspected case of a new/emerging WRD reported in these systems is interpreted as an alert signal, which is strengthened if work-relatedness is confirmed by highly qualified experts. This is followed by putting preventive actions in place. Several good examples of systems specifically designed for detecting new/emerging WRDs have been implemented in EU countries in recent years (e.g. SIGNAAL, OccWatch, the Occupational Health Warning Group (GAST), etc.), demonstrating a step forward in dealing with this issue in the EU.

The systems identified in the other three groups can also contribute to identifying new/emerging WRDs, even though they are not designed in accordance with the sentinel approach. Compensation-based systems (Group 1) are not generally designed, but can be used for detecting new/emerging WRDs when they include an 'open list' approach that allows the reporting of suspected cases of WRDs, which are then further investigated. Non-compensation-based systems primarily designed for data collection and statistics (Group 2) can also be used for the detection of new/emerging WRDs. However, suspected cases of new/emerging WRDs should be evaluated by relevant experts so that appropriate actions can be taken and the cases can be followed up and linked to prevention. Examples of systems that can be used to detect new/emerging WRDs are the French RNV3P, the UK Health and Occupation Research Network (THOR), the Italian system for the surveillance of work-related diseases (MALPROF), the Norwegian Registry of work-related diseases (RAS) and the Spanish Surveillance System in Navarre. Public health surveillance systems aimed at workers and non-workers (Group 4) have a wide scope for monitoring the health of the general population and are generally not aimed at detecting new/emerging WRDs. Nevertheless, these systems can be a valuable complementary source of information to the systems described in the other three groups.

### Comprehensive data collection and coverage

In addition to the variety in the design of sentinel and alert systems described in the report, the systems identified also draw on several different approaches to data collection. The reporting of new cases (mainly done by physicians) was the predominant method of data collection. However, other supplementary approaches were also identified. For instance, several systems use data mining of different information sources. In the case of the Washington SHARP programme this is done by reviewing data from workers' compensation databases, while in the French RNV3P programme this is

done by retrieving new disease-exposure associations in a non-compensation-related database. In the case of the disease-specific monitoring system NODS in New Zealand, data mining is done by panels of specialists in the national registry of respiratory diseases to monitor work-related respiratory diseases; and in the case of the Italian OCCAM programme the data mining looks at cancer registries to detect work-related cancer.

In terms of disease coverage, we identified systems for monitoring all WRDs and systems aimed at a specific group of WRDs. Among the latter, most were designed to detect work-related respiratory diseases: the Washington SHARP Asthma Surveillance Program (Group 1), the UK Surveillance of Work-related and Occupational Respiratory Disease (SWORD) scheme (part of the THOR scheme), the Surveillance of Occupational Respiratory Diseases in South Africa (SORDSA) programme, the Ontario Work-Related Asthma Surveillance (OWRAS) programme in Canada, the Surveillance of Australian Workplace Based Respiratory Events (SABRE) programme in Australia, the Programme for surveillance of professional asthma (ONAP2) in France (Group 2) and the NODS Respiratory Diseases Panel in New Zealand (Group 3). As regards other WRDs, we identified systems for monitoring the following groups: work-related skin diseases (the UK THOR-Occupational skin surveillance (EPIDERM) programme and the Washington SHARP Dermatitis Program), work-related cancer (OCCAM in Italy and the NODS Cancer Panel in New Zealand), musculoskeletal disorders (Programme for the surveillance of musculoskeletal problems (TMS) in France and the Washington SHARP Musculoskeletal Disorders Program), pleural mesothelioma (the French National Programme for Mesothelioma Surveillance (PNMS)), work-related infectious diseases (UK THOR-Surveillance of Infectious Diseases At Work (SIDAW)), WRDs related to nanomaterial exposure (EpiNano in France) and WRDs related to pesticide exposure (SENSOR Pesticides and PISP in the USA). The New Zealand NODS had two additional specialist panels — the Chemical Panel and the Solvent Panel — for monitoring WRDs related to chemical and solvent exposure.

However, we could not identify any active systems specifically aimed at monitoring work-related mental illnesses. Data on work-related mental ill-health collected from occupational physicians reporting to the Occupational Physicians Reporting Activity (OPRA) programme and from general practitioners reporting to THOR-GP in the United Kingdom show that approximately 40 % of reported cases are cases of mental ill-health. These data illustrate the growing significance of stress and mental illness in work-related ill-health and that they are one of the main emerging risks. However, the monitoring of work-related mental illnesses is still poor, and obviously in need of improvement. The development of a surveillance system focusing specifically on work-related mental ill-health or the inclusion of mental illness surveillance in the existing monitoring systems for new/emerging WRDs is warranted.

**Linking data on exposure and health effect monitoring**

Exposure assessment is an important step in all types of work-related surveillance systems aimed at detecting new/emerging risks and WRDs. Integrating the investigation of exposure and the surveillance of health effects may be a promising approach for assessing these new risks, as illustrated by the French EpiNano programme. The first part of the EpiNano project focuses on exposure identification and assessment, and involves developing an exposure registry of companies and workers that produce or

handle nanomaterials, and a detailed qualitative exposure assessment. In the later phases, more attention will be paid to the adverse health effects of the exposure, through cohort and cross-sectional studies with exposed workers.

Other systems identified in this review were mainly focused on health effects, and exposure assessment was one of the steps in data collection and work-relatedness evaluation. Two main approaches towards exposure assessment were identified. In the first case, exposure was described by reporters who usually listed the exposure(s) they thought were linked with health complaints. This was common practice in the non-compensation-based systems primarily designed for data collection and statistics (Group 2) and public health surveillance aimed at workers and non-workers (Group 4). On the other hand, all sentinel systems (Group 3) and some of the compensation-based systems (Group 1) provided a more thorough additional exposure assessment, which was taken into account when judging the work-relatedness of each reported case. For instance, in the New Zealand NODS, multidisciplinary teams carried out workplace interventions for a detailed investigation, exposure assessment and data collection. Similarly, in the US Health Hazard Evaluation (HHE) programme, all the necessary information, including that on exposure, is collected through workplace evaluations performed by a multidisciplinary team. This approach is recommended to better understand the link between different kinds of exposure and health effects and to improve the quality of the reporting of new/emerging WRDs.

**Exchange of information and better link with prevention**

Generally, one of the main weak points of the systems identified in the review is a poor link with preventive actions. Collected data are mainly disseminated through conservative means, such as case reports, international conferences and symposia etc., whereas the data are hardly used for prevention. However, some examples of systems with a good link to prevention exist, mainly derived from the sentinel systems group (Group 3) and a couple from the non-compensation-related systems (Group 2).

The French RNV3P is a good example of dissemination and the exchange of information at a national level, which can be used to initiate preventive actions. Upon detecting a signal, this system provides an internal alert to clinicians in the RNV3P network, conducts a search for similar cases outside the network and a widely diffuses the information via ANSES to authorities, so that necessary actions can be taken. In addition, all cases of suspected new/emerging WRDs are collected in the corresponding web-based information system (database), with coded variables that enable periodical data mining.

Several systems, such as the Washington SHARP Asthma Program, the OCCAM programme in Italy and the EpiNano project in France, use the data collected to identify high-risk economic sectors and industries. The SHARP Asthma Program calculates a prevention index for different occupations and sectors, which further prioritises preventive actions and recommendations. Similarly, data collected in OCCAM are analysed to provide information on specific economic sectors that are at risk of work-related cancer. EpiNano uses a narrower approach, identifying companies that produce or handle nanomaterials, and following workers who are potentially exposed to nanomaterials. The identification of occupations and economic sectors that are at a high risk of new/emerging WRDs, as illustrated in these systems, can lead to the development and implementation of targeted, timely preventive actions.

Another example of a direct link with prevention is portrayed in the US SENSOR. In this system, a confirmed case report triggers three types of interventions. First, health officials contact the individual with an identified work-related disease and offer an intervention to improve health or slow the progression of the disease. Second, action is directed towards co-workers, who are often at risk of developing similar occupational disorders because of common workplace exposures. Third, in response to reports of individual cases, the surveillance centre can coordinate and/or carry out interventions directed at specific causes at the workplaces.

Two sentinel systems — SIGNAAL and OccWatch — provide an international exchange of information on several levels. Starting with a work-relatedness evaluation, these systems gather experts on new/emerging risks from different countries (Belgium and the Netherlands in SIGNAAL and Modernet countries in OccWatch) who can share similar cases identified in their countries and participate in the final decision on the work-relatedness of the reported case. This information is exchanged on an online platform, which is also used for further dissemination of the collected data. These are promising examples of international collaboration that could potentially lead to EU-wide surveillance of new/emerging WRDs.

# 1 Introduction

## 1.1 The burden of work-related diseases

Occupational factors contribute significantly to the global burden of disease. It is estimated that 70-90 % of chronic diseases can be attributed to environmental factors, including work (Rappaport, 2011). Work-related morbidity and mortality not only harm workers and their families, but also add to the economic burden of society, which in turn leads to the loss of productivity as well as increased demands for medical services. The best estimate of global work-related deaths is approximately 2.3 million per year, with work-related diseases (2.0 million deaths annually) rather than accidents being responsible for the vast majority (Takala et al., 2014). While the number of occupational accidents has decreased in industrialised countries thanks to prevention and structural changes, work-related illnesses that have a long latency period are clearly increasing.

The number of work-related deaths is likely to be considerably underestimated owing to shortcomings in the available data (Driscoll et al., 2005). Hence, the early detection of health impairment, whether induced or partly caused by work-related factors, remains difficult. Criteria for the notification and recognition of occupational diseases (ODs) differ significantly in European Union (EU) countries, in both the legal and social security context, thus making figures on occupational and work-related diseases unreliable, and limiting their utility for monitoring existing ODs in EU countries, or for identifying newly occurring ODs (Spreeuwers et al., 2010).

Moreover, continuous changes in work and working conditions result in the rise of new occupational health risks and possibly new work-related diseases (WRDs). For example, there is a growing impact of chronic work-related problems such as musculoskeletal disorders, psychosocial risks and stress at work. New agents are constantly being introduced to the workplace, with no clear assessment of long-term health risks. The rapid development of nanotechnology, for example, has given rise to additional health concerns. Risk factors from changing work environments also present potential threats to the reproductive capacity of parents-to-be and to the health of their unborn children.

The health consequences of new technologies as well as the currently unknown effects of existing technologies are a cause for concern among the working population, occupational safety and health professionals, policy-makers, and insurers (Spreeuwers et al., 2008). Research emphasises a need for timely, specific knowledge regarding new occupational health risks. In cases with insufficient knowledge of these risks, opportunities for intervention and prevention may be missed (Harremoës, 2001).

These concerns were reflected in the priorities identified in the EU strategy 2007-2012 on health and safety at work (European Commission, 2007) and were also expressed in the European Parliament resolution on the mid-term review of this strategy (European Parliament, 2011). The European Agency for Safety and Health at Work (EU-OSHA) established a 'Risk Observatory' with a special focus on emerging risks.

New work-related hazards may introduce new work-related or occupational diseases. Recommendation 2003/670/EC2 concerning the European schedule of occupational diseases (European Commission,

2003) does not explicitly focus on new work-related illnesses or occupational diseases, but is more general. It calls for active involvement of all players in developing measures for the effective prevention of occupational illnesses; it recommends the collection of information linked to the epidemiology of Annex II diseases and any other disease of an occupational nature; and it promotes research in the field of ailments linked to an occupational activity, in particular ailments listed in Annex II, and disorders of a psychosocial nature that are related to work.

In addition, the EU Occupational Safety and Health (OSH) Strategic Framework 2014-2020 (European Commission, 2014), points out 'improvement of the prevention of work-related diseases by tackling new/emerging risks without neglecting existing risks' as one of the major challenges in OSH.

## 1.2 Definitions and typology of new work-related diseases

A 'new occupational safety and health risk' has been defined by EU-OSHA (Flaspöler et al., 2005) as any occupational risk that:

- was previously unknown and is caused by new processes, new technologies, new types of workplaces, or social organisational change; or
- is a longstanding issue that is newly considered a risk as a result of a change in social or public perceptions; or
- new scientific knowledge allows a longstanding issue to be identified as a risk.

New WRDs can be categorised in various ways. Some examples are given in Table 2. Some more or less new syndromes, caused by changes in work and working conditions, may form a new combination of health complaints resulting from previously unknown causes for these symptoms (e.g. popcorn disease and progressive inflammatory neuropathy (PIN)). In other cases, new data allowed to make new cause-effect links between known health disorders and existing risk factors, such as breast cancer due to long-term night-shift work or respiratory illness caused by fine dust.

**Table 2: Categories and examples of new work-related diseases**

| Category | Diseases | Causes |
|---|---|---|
| New diseases due to changes in work and working conditions | Progressive inflammatory neuropathy (PIN) | Exposure to aerosolised pig neural tissue in swine slaughterhouse workers |
| | Popcorn disease — bronchiolitis obliterans | Diacetyl-containing flavourings |
| | Interstitial lung disease (Flock worker's lung) | Textile workers' exposure to synthetic polymeric fibres in nylon flocking plants |
| | Breast cancer | Long-term night-shift work |

| Category | Diseases | Causes |
|---|---|---|
| New knowledge about diseases caused by known forms of exposure | Cardiovascular diseases | Exposure to ultrafine particles |
| | Lung infections | Exposure to welding fumes |
| Newly recognised consequences of occupational exposure of offspring via their parents | Congenital abnormalities | Pesticides, endocrine disruptors |
| | Cancer in children | Radiation, pesticides |
| | Delayed neuropsychological development | Lead, mercury, pesticides |

## 1.3 Monitoring new work-related diseases

The detection of new occupational risks requires additional instruments to those already in use for monitoring known ODs. The systems that register recognised and compensated diseases do not fulfil all policy needs because surveillance is primarily aimed at already 'established' ODs. Consequently, these systems are less suitable for detecting 'new' occupational or work-related diseases. Furthermore, it is not possible to detect new WRDs using a single method. A comprehensive approach, which uses several complementary methods, is required. The literature reveals several possible approaches to identifying new occupational health risks, such as data mining in existing databases (Bonneterre et al., 2012) or spontaneous reporting of new occupational health risks (Lenderink et al., 2015). The chosen method might be influenced by the type of disease and its prevalence in the (risk) population. For instance, in the case of a rare disease with a high aetiological fraction (i.e. work is an important cause of this disease), 'spontaneous reporting' by a large group of physicians or workers would be a good monitoring instrument. In contrast, in cases of frequently occurring illnesses with a low aetiological fraction (i.e. work is one cause among many others), epidemiological research among large groups of workers is more valuable than individual reports (Van der Laan et al., 2009).

'Early warning systems' is an umbrella term for timely surveillance systems that collect information on diseases to initiate health interventions and prevention. These early warning systems should not be confused with systems that screen for early health effects of already known diseases (i.e. detection of early health effects; a specific form of health surveillance). These early warning systems aim to detect new combinations of health problems, exposure and work settings at an earlier stage to prevent occupational health problems. A comprehensive early warning system can be looked upon as a chain of information and communication systems, made up of sensors (tools to detect events or changes in the environment to provide a corresponding output), event detection (the ability to discern an event or a signal from its background information), decision support (tools to support the decision-making process after detection of an event or signal), and message-broker subsystems (tools to generate messages for stakeholders derived from a detection system) that aim to forecast and identify adverse effects on health, providing time for response to minimise the impact of the potential health threat (Waidyanatha, 2009).

Several health fields already benefit from these types of surveillance systems (e.g. the EU Early Warning and Response System (EWRS) for infectious diseases (Lakes et al., 2007) or the EU Early Warning System for psychoactive substances from the European Monitoring Centre for Drugs and Drug Addiction (EMCDDA) (European Monitoring Centre for Drugs and Drug Addiction, 2005)). In addition, an interesting example comes from pharmacovigilance, or the surveillance of drug side effects. However, despite surveillance efforts, unexpected and serious adverse drug reactions (ADRs) can occur even after testing and marketing. Research has underscored the importance of systems for the spontaneous reporting of ADRs through pharmacovigilance. Therefore, spontaneous reporting of ADRs is encouraged and the information in ADR databases is continuously subject to systematic analysis (Aagaard and Hansen, 2009). Similarly, an important source of information regarding new/emerging occupational risks may come from the early detection and reporting of a new WRD. For these newly emerging diseases, rapid and valid detection of the underlying exposures and health risks is necessary for prevention. The detection of new risks should also be followed by effective dissemination of the relevant knowledge to all stakeholders to establish preventive measures.

## 1.4 Objective and research questions

The current report is the main deliverable of Task 1 of EU-OSHA's: 'Methodologies to identify work-related diseases — Review on sentinel and alert approaches' project. The overall objective of this project is to describe a number of approaches that have been taken to try and identify emerging work-related health problems and diseases. It aims to support the development of monitoring instruments, and could help design targeted health surveillance measures to support the early recognition of work-related diseases and risks factors. It is mainly intended for policy-makers at the national and EU level, including social partners, researchers, those involved in occupational disease recognition and statistical data, and those who develop approaches for health surveillance of workers. It should provide these actors with policy recommendations for setting up systems that can support the development of their area of action. It should also contribute to sharing of information regarding emerging health problems linked to specific exposures and to identify which priorities, if any, are currently set for the identification of emerging diseases (e.g. sectors, exposures, types of diseases).

The project consists of five main tasks:

- Task 1. Desk research — literature review.
- Task 2. In-depth description of a selection of sentinel or alert systems — one for each type described above (typology) and for different countries, through interviews and qualitative analysis.
- Task 3. Support for a seminar to discuss outcomes 1 and 2.
- Task 4. Final report including analysis and policy options.
- Task 5. Support for a workshop to disseminate findings to stakeholders.

The objective of this Task 1 review is to provide insight into the approaches used to identify emerging WRDs and to complement the official figures of notified, recognised and compensated diseases, which

are usually the only comparative sources of information on the extent of health problems encountered at work. Its aim is to establish which systems and approaches are suitable to identify new/emerging WRDs. Furthermore, the results of the present review will provide a scientific basis for the realisation of the four remaining Tasks of the project.

The following research questions will be addressed in this review:

1. What existing OSH alert and sentinel systems can detect new/emerging WRDs?
2. What are the main characteristics of these systems?
3. What is the basic typology of these systems?

# 2 Methodology

## 2.1 Review of scientific literature

A literature study was carried out to identify sentinel and alert systems for detecting new/emerging WRDs. An extensive search strategy was developed to identify potentially pertinent articles in electronic databases. The strategy combined search terms for the following three concepts: (1) surveillance/reporting system; (2) occupational/work-related diseases; and (3) new/emerging risks. The search strategy was tested against a list of 'must-have' articles related to already known sentinel and alert systems on work-related ill-health. The following databases were searched from the first day of entries until January 2016: Medline through PubMed, Embase and Web of Science. The search strategy was adapted to suit each database being searched. No restrictions were applied as regards publication type, language or date. Furthermore, the snowballing technique was used to retrieve additional references in the bibliographies of the relevant and most cited articles and documents. A description of search strategy is presented in Appendix A.

## 2.2 Grey literature review

We used different approaches to identify grey literature, which is also vital for this review. Firstly, we performed a formal search in databases that are considered to contain the most important grey literature. We used the same systematic search and inclusion, and data extraction and analysis process as used for the review of the scientific literature, in the databases OpenGrey and OSH-update. Secondly, we used existing data from three surveys that were recently held among occupational disease experts in Europe: (1) the European Union "Report on the current situation in relation to ODs' systems in EU Member States and EFTA/EEA countries, in particular relative to Commission Recommendation 2003/670/EC concerning the European Schedule of Occupational Diseases and the gathering of data on relevant related aspects" (European Commission, 2013); (2) a survey on monitoring systems for occupational diseases among Monitoring Occupational Diseases and tracing New and Emerging Risks in a NETwork (Modernet) participants (2011-2012); and (3) the inventory of early warning systems in use in all European countries (clinical watch systems, databases for data mining, use of biomarkers in health surveillance, etc.), carried out by the Dutch National Institute for Public Health and the Environment, RIVM Bureau Reach, in preparation of the international conference on how to ban work-related cancer in the EU, organised by the Dutch Ministry of Socials Affairs and Employment in May 2016 (Palmen, 2016). Finally, we searched relevant EU and research institute websites to retrieve additional grey literature sources.

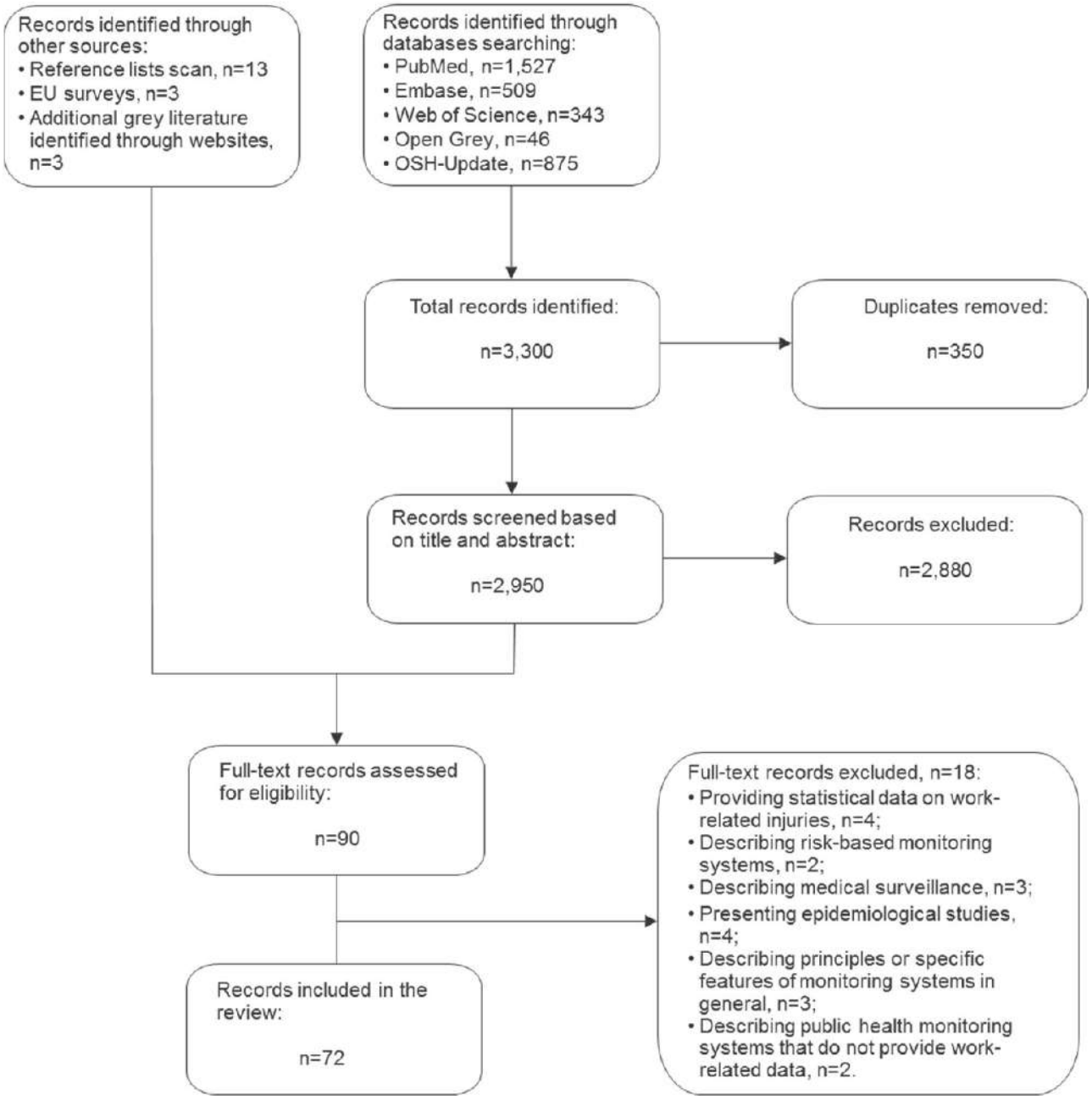
## 2.3 Selection of studies

References from all databases were gathered into a reference managing programme (EndNote). An initial screening of the titles and abstracts was carried out by two researchers independently. The full publications were obtained for those that were considered by both researchers to fit the following inclusion criteria:

- studies describing the design and functioning of alert systems for new/emerging WRD;
- studies describing the results of alert systems that report new/emerging risks.

Next we assessed the remaining references for inclusion based on the full-text assessment. The PRISMA guidelines (Moher et al., 2009), which provide very clear step-by-step guidance on reporting, were used in this systematic review. The flow chart in Figure 2 depicts the flow of information through the different phases of the review. It maps out the number of records identified, included and excluded, and the reasons for exclusion. The 72 records included in the review described a total number of 75 systems.

**Figure 2: PRISMA flow chart**



## 2.4 Data extraction and management

The two reviewers independently extracted data on the following characteristics of sentinel systems:

- country
- organisation/institution maintaining the system
- aim of data collection
- type of work-related symptoms and diseases reported
- coverage of the system
- type of reporter
- reporting mechanism
- data collected by the system, evaluation of work-relatedness
- follow-up of possible new/emerging risks
- link with prevention
- collection in a database
- start date
- end date (if the system is no longer active), and
- formal evaluation of the system and website.

We resolved disagreements by discussion in pairs. If disagreement persisted, a third reviewer made the final decision. All data were extracted into an Excel table (data extraction form). However, the large amount of retrieved information made it impossible to present the data extraction form in its initial version. Thus, we modified and coded the Excel table into a more concise format without losing essential information. The modified data extraction form, containing the list of all identified systems and basic characteristics of the systems, is presented in Appendix B. During the data extraction process, common characteristics of the systems emerged, as did several possibilities for their classification. In addition, certain concepts related to WRD/ODs and their monitoring had to be clarified to provide a clearly structured typology of these systems.

## 2.5 Clarification of concepts

### *2.5.1 Occupational diseases and work-related diseases*

**EU context**

In the EU context, the approach to OD statistics is set out in the EU Regulation (EC) No 1338/2008 on the Community statistics on public health and health and safety at work (The European Parliament and the Council of the European Union, 2008):

Annex V of the regulation contains the definitions, which have been adapted for the purpose of data collection:

‘A case of **occupational disease** is defined as a case recognised by the national authorities responsible for recognition of occupational diseases.’

**'Work-related health problems and illnesses** are those health problems and illnesses that can be caused, worsened or jointly caused by working conditions. This includes physical and psychosocial health problems.'

These definitions reflect the sovereignty of Member States with regards to recognised occupational diseases in relation to their national policies.

**EU schedule of occupational diseases**

In addition, EU Recommendation 2003/670/EC on the schedule of occupational diseases (European Commission, 2003) recommends Member States introduce national legislation on specific ODs, and their compensation, prevention and collection of statistical data. The Recommendation covers 10 aspects of ODs: recognition, compensation, prevention, target setting, reporting and recording, epidemiology, research, diagnosis, statistics and awareness-raising. It calls on Member States to

- introduce as soon as possible into their national laws, regulations or administrative provisions concerning scientifically recognised ODs liable for compensation and subject to preventive measures, listed in the European schedule in Annex I;
- introduce into their national regulations the rights of a worker suffering from an ailment that is not listed in Annex I, but which can be proven to be occupational in origin, in particular for the diseases listed in Annex II;
- develop and improve effective preventive measures for the ODs mentioned in the European schedule in Annex I, actively involving all players;
- ensure that all OD cases are reported and progressively make the country's OD statistics compatible with the European schedule;
- introduce a system for the collection of information or data concerning the epidemiology of the diseases listed in Annex II and any other disease of an occupational nature;
- ensure that documents to assist in the diagnosis of ODs included in the national schedules are widely disseminated, taking into account the notices for the diagnosis of ODs published by the Commission;
- promote the active role of national health care systems in preventing ODs, in particular by raising awareness among medical staff with a view to improving the knowledge and diagnoses of these illnesses.

Quantified national objectives should be adopted to reduce the rate of recognised occupational illnesses, especially in activity sectors in which they are above average. Annex I of the Recommendation contains a list of ODs referred to as 'diseases that must be linked directly to the occupation'. Annex II presents the additional list of diseases suspected of being occupational in origin. It is suggested that these ODs 'should be subject to notification and may be considered at a later stage for inclusion in Annex I to the European schedule'. The development of a European schedule of ODs has three main objectives:

- to improve knowledge of the subject at the European level (collection and comparability

of data);

- to reinforce risk prevention: the Member States are invited to define quantified targets to reduce the rates of such diseases;
- to provide aid for affected workers, who will be more easily able to prove the link between their occupation and their condition, and to claim compensation.

Article 2 of the EU Recommendation reflects the sovereignty of Member States, explaining they do not need to adopt the EU list (Annex I) literally; rather that they 'themselves determine the criteria for the recognition of each occupational disease in accordance with the national laws or practices in force'. This means that the EU list is intended to protect against the same risks in all Member States, but that they need not all do so in the same way. In addition, it is recommended that each Member State is able to recognise diseases that are not yet in Annex I but that fulfil similar criteria — especially those listed in Annex II — and that the diseases are included in the Member State's national list.

Annex I comprises 108 diseases, divided into five groups according to their causative factors (Groups 1, 4, 5: chemical exposure, exposure to germs and parasites, physical exposure) or according to the affected organs (Groups 2, 3: skin, respiratory tract — most of which are also related to causative substances). The 'Information notices on occupational diseases, a guide to diagnosis' document contains more detailed information on these diseases and provides diagnostic criteria.

Annex II comprises 48 further diseases, like Annex I, divided into the same five groups; most of them (36) refer to causation by chemical exposure.

**National lists of occupational diseases**

In the report published in 2013 on the situation in relation to ODs' systems in the EU and in particular relative to Commission Recommendation 2003/670/EC (European Commission, 2013), an overview is provided of how each of the various recommendations have been adopted by 27 EU Member States and two EFTA countries: Austria, Belgium, Bulgaria, Switzerland, Cyprus, Czech Republic Germany, Denmark, Estonia, Spain, Finland, France, Greece, Hungary, Ireland, Iceland, Italy, Lithuania, Latvia, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Sweden, Slovenia, Slovakia and the United Kingdom. Nearly all the countries (26 out of the 29) have a national list of ODs (Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Germany, Denmark, Estonia, Finland, France, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Malta, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Switzerland and the United Kingdom). The United Kingdom and Cyprus have two lists, one for compensation and one for prevention. The Netherlands, Iceland and Sweden do not have a national list of ODs, and ODs are not recognised or compensated for in a workers' compensation system. Spain has only a proof system and individual cases with a suspected OD are recognised on the basis of general criteria. The Netherlands and Iceland legally consider ODs in the same way as any other disease.

These lists are established for the purposes of recognition and compensation, i.e. *they specify the diseases entitled to compensation, and depending on the country in question, entail a more or less*

*strong presumption of work-related origin. In some countries, the same list can also be used as a basis for a statistical reference system or a reporting system.*

The degree of exhaustiveness of the lists varies depending on the country. Some may have a shortlist of substances supplemented by a few precisely specified diseases (e.g. Switzerland), or a list of diseases together with compulsory or indicative criteria for recognition (as in France, Italy, Spain and Portugal). Again, the different forms of lists means that the diseases liable to be recognised as work-related can be described with varying precision. In many countries, the national list is similar in structure to Annex I of the European list. Apart from these differences of form, there are of course differences in content, since the national lists reflect countries' decisions to cover particular diseases through OD insurance.

**Open or complementary systems**

Of the countries with a list, only half (Austria, Belgium, Bulgaria, Denmark, Finland, France, Germany, Ireland, Italy, Latvia, Norway, Portugal and Switzerland) also have a complementary system or proof system by which it is possible to recognise the work-related origin of a disease that does not appear on the national list. This system is by nature more restrictive than the list system, because the onus of proof lies with the victim and not the insurance organisation. Spain, for its part, has a de facto complementary system, because ODs that do not appear on the national list can be recognised as accidents at work.

While almost all the countries have a list of ODs, not all have a specific compensation system for these diseases (23 out of 29). By a specific compensation system we mean a system that grants different benefits to those given for a common disease. In these 23 countries, the benefits are often more generous: cash benefits may be higher; the way of calculating the amount of the pension (in the case of permanent injury) is more favourable to the victim; and other benefits such as rehabilitation may be offered. In the six countries that have no specific system of compensation (Estonia, Greece, Hungary, Iceland, the Netherlands and Slovenia), ODs — and also accidents at work — do not come under separate insurance arrangements. Diseases and a temporary loss of work ability come under the health/sickness insurance regime, while disability and death are covered by the relevant pension/death insurance provisions. In other states, such as the United Kingdom, additional general benefits are available, which cover everyone affected by sickness or disability.

**International Labour Organization background**

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

- **occupational diseases** — having a specific or a strong relation to occupation, generally with only one causal agent, and recognised 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.

**ILO list of occupational diseases**

The ILO governing body approved a new list of ODs on 25 March 2010 during its 307th Session (International Labour Organization, 2010). This new list replaces the preceding one in the annex of Recommendation No 194, which was adopted in 2002 (International Labour Organization, 2002). The new list includes a range of internationally recognised ODs, from illnesses caused by chemical, physical and biological agents to respiratory and skin diseases, musculoskeletal disorders and occupational cancer. Mental and behavioural disorders have now for the first time been specifically included in the ILO list. This list also has open items in all sections dealing with the aforementioned diseases. The open items allow the recognition of an occupational origin of diseases not specified in the list if a link is established between exposure to risk factors arising from work activities and the disorders suffered by the worker. The criteria used by the tripartite experts for deciding what specific diseases are considered in the updated list include a causal relationship with a specific agent, exposure or work process; occurrence in connection with a specific work environment and/or in specific occupations; occurrence in groups of workers with a frequency that exceeds the average incidence in the rest of the population; and scientific evidence of a clearly defined pattern of disease following exposure, and plausibility of cause.

There are some notable differences between the structure of the ILO list and the EU list of ODs:

- The EU list differentiates between the list of ODs (Annex I) and the list of suspected ODs (Annex II), whereas the ILO includes all ODs in one list.
- Musculoskeletal disorders and mental or behavioural disorders (much debated in the EU) are included in the ILO list of ODs.
- The ILO list uses a catch-all clause in every disease category. For example, under the heading 2.4 ‘Mental and behavioural disorders’, one disease is mentioned (2.4.1. post-traumatic stress disorder), followed by 2.4.2. ‘Other mental or behavioural disorders not mentioned in the preceding item where a direct link is established scientifically, or determined by methods appropriate to national conditions and practice, between the exposure to risk factors arising from work activities and the mental and behavioural disorder(s) contracted by the worker’.

Both the EU and ILO list have technical background papers with a description of the ODs and their medical and exposure criteria.

### 2.5.2 Surveillance systems

Public health surveillance is the ongoing systematic collection, analysis and interpretation of data, closely integrated with the timely dissemination of these data to those responsible for preventing and controlling disease and injury (Thacker and Berkelman, 1988). Surveillance differs from screening in the sense that surveillance aims at collecting data to measure magnitude, changes and trends in

populations in order to put in place intervention in defined populations. Screening, in contrast, aims to identify individuals with infection or disease with the objective of either personal intervention or protection of the public (e.g. blood donors). Another objective can be the measurement of prevalence in screened populations.

In the context of occupational health, health surveillance is a set of activities to monitor and follow up occupational and work-related diseases and injuries. There are several reasons for this type of surveillance. Information on the incidence and prevalence of occupational and work-related diseases and injury provides a sound basis for prevention and control. The data enable the analysis of trends, to determine research and control priorities and strategies, and to evaluate the effectiveness of interventions. Occupational health surveillance can also lead to discovery of new associations between occupational agents and accompanying disease (Aw and Koh, 2003).

Other types of surveillance may also be useful for occupational health.

**Active surveillance** is a system that relies on regular contact with health care providers (e.g. occupational physicians, general practitioners, medical specialists, etc.) or the working population to seek information regarding health conditions. In the occupational health context, this can take the form of periodic clinical and/or physiological assessment of all workers, medical examinations of workers exposed to specific health hazards, or screening and biological monitoring of selected groups of workers. For the individual, the rationale is to detect adverse health effects resulting from occupational exposures at as early a stage as possible, so that appropriate preventive measures can be instituted promptly. This is a form of secondary prevention. Active surveillance provides the most accurate and timely information, but is also expensive. Examples of active surveillance in occupational health are the pre-employment screening of health care workers (e.g. for hepatitis B/C or tuberculosis) or the active health surveillance programmes aimed at workers at risk of a specific disease (e.g. contact eczema or occupational respiratory diseases). Health surveillance programmes can be organised in various ways. For example, in a recent project in Belgium, a data warehouse was formed to make OSH data available for research and to investigate sector-specific health problems. Collected information is further used in the implementation of sector-oriented health surveillance programmes (Godderis et al., 2015). However, this type of surveillance is mainly part of the medical surveillance of workers, rather than of sentinel and alert systems for occupational and work-related diseases. As medical surveillance is beyond the scope of this review, we will refer back to this type of surveillance only if it constitutes a monitoring system identified in the present review.

**Passive surveillance** is a system by which a health jurisdiction such as a centre of OSH, labour inspectorate, insurance fund, etc. receives reports submitted from health care providers (insurance physicians, hospital specialists, occupational physicians from OD consultation centres, etc.) or less frequently, from employers or employees. Passive surveillance is a relatively inexpensive strategy for covering large areas, and it provides critical information for monitoring a community's health. However, because passive surveillance depends on people in different institutions to provide data, data quality and timeliness are difficult to control. Most of the occupational registries and work-related illness

notification systems in occupational health are passive surveillance systems. Data collection in these systems depends on the reporters (occupational physicians, general practitioners, medical specialists, etc.), who either voluntarily, or because they are obliged by law to do so, report cases identified in their daily practice. Under-recognition and underreporting are common problems in these types of systems.

A **sentinel surveillance** system can be used when high-quality data concerning a particular disease are needed that cannot be obtained through a passive system. Selected reporting units, with a high probability of seeing cases of the disease in question, good laboratory facilities and experienced well-qualified staff, identify and notify of certain diseases. Whereas most passive surveillance systems receive data from as many health workers or health facilities as possible, a sentinel system deliberately involves only a limited network of carefully selected reporting sites. A case is seen as a sentinel health event (SHE) that indicates a possible risk factor of a specific health risk. The concept of SHE (occupational) is that certain WRDs, health impairments or untimely deaths can be used as indicators of occupational health risks. At best, these cases may initiate scientific research in the sector concerned. However, these events may be warning signals that OSH practices at the given workplace are insufficient and that intervention (e.g. substitution, engineering control, personal protection, or medical care) is necessary (Rutstein et al., 1983).

# 3 Results

## 3.1 Identification and basic typology of systems

We identified 75 monitoring systems in the 72 references included in the review. The identified systems were mainly implemented in EU countries, but also outside Europe (USA, Canada, Australia, Singapore, Taiwan, etc.). We developed an algorithm to divide these systems into different types, addressing the questions in Table 3.

**Table 3: Algorithm for classification of systems**

| No | Question | Answers |
|---|---|---|
| 1 | Is the system aimed at workers or at the general public? | Workers/general public including workers |
| 2 | Which type of surveillance does the system use? | Passive/active/sentinel |
| 3 | Is the system linked to workers' compensation?<br>If yes, what type of system? | Yes/no<br>Only list/list and complementary/no list at all |
| 4 | Which diseases or health problems are reported? | General (all diseases)/specific<br>(one or subset of diseases) |
| 5 | Does the system also aim to alert of new/emerging work-related health problems? | Yes/no |

Of the 75 systems, 68 cover workers and seven cover the general public, including workers.

Of the 68 systems aimed at workers, 56 use passive surveillance, no systems use active surveillance and 12 systems use sentinel surveillance.

Of the 56 systems using passive surveillance, 22 are linked to a workers' compensation system (coded 1).

Of the 22 systems linked to a workers' compensation system, five have a prescribed list of ODs that can be reported for compensation (coded 1A). Eleven systems have a list of ODs but also a complementary open system in which the reported disease needs proof of work-relatedness (coded 1B) and six systems have a claim that can be filed without a prescribed list (coded 1C). The systems coded 1B+ and 1C+ are also suitable for identifying new/emerging work-related health problems.

Of the 56 systems with passive surveillance, 34 are non-compensation-related systems primarily designed for data collection and statistics (coded 2). Of these, 14 are for all work-related or occupational diseases (coded 2A), three of them also aim additionally the identification of new/emerging work-related health problems (coded 2A+). Eighteen non-compensation systems focus on one or a subset of work-

related or occupational diseases (coded 2B), and two non-compensation systems are for work-related injuries, accidents and diseases (coded 2C).

Of the 12 sentinel surveillance systems, six are for all work-related or occupational diseases (coded 3A), of which four also additionally aim to alert of new/emerging work-related health problems (3A+). Another six focus on one or a subset of work-related or occupational diseases (coded 3B).

Of the seven systems focusing on the general public including workers, two use active surveillance and five have passive surveillance. Two systems gather information on all work-related or occupational diseases (coded 4A) and five systems aim to gather information on one or a subset of work-related or occupational diseases.

**Table 4: Typology of all identified 75 systems (see Table 5 for list of systems belonging to each code)**

| Population | Type of surveillance | Related to compensation | Based on list and/or open or no list at all | Able to retrieve new/emerging health risks | Code |
|---|---|---|---|---|---|
| Workers (68) | Passive (56) | Workers' compensation (22) | List systems (5) | | 1A |
| | | | List + Open systems (11) | | 1B |
| | | | No list (6) | 1C+ (1) | 1C/1C+ |
| | | | **General/specific** | | |
| | | Non-compensation systems (34) | All WRDs (14) | 2A+ (3) | 2A/2A+ |
| | | | One or subset of diseases (18) | | 2B |
| | | | Diseases and injuries (2) | | 2C |
| | Sentinel (12) | Non-compensation (12) | All WRDs (6) | 3A+ (4) | 3A/3A+ |
| | | | One or subset of diseases (6) | | 3B |
| General public including workers (7) | Active (2) | | All WRDs (2) | | 4A |
| | Passive (5) | | One or subset of diseases (5) | | 4B |

**Table 5: List of systems belonging to code categories defined in Table 4**

| Type | Country | Name or description of system, website |
|---|---|---|
| 1A | Russia | Russian reporting of suspected ODs during mandatory worker medical examinations |
| | Spain | Comunicación de Enfermedades Profesionales en la Seguridad Social (CEPROSS); Occupational Diseases Registry of the Social Security System for occupational diseases of the official list approved by a Royal Decree, and Patologías no traumáticas causadas por el trabajo (accidentes de trabajo) de la Seguridad Socia (PANOTRASTSS) (annex to the OD list to register non-traumatic health effects that may be considered ODs in the future, but are not today)<br>http://www.seg-social.es/ |
| | United Kingdom | Industrial Injuries Disablement Benefit Scheme (IIDB)<br>www.gov.uk/industrial-injuries-disablement-benefit |
| | Ireland | Occupational Injury Benefit and Disablement Benefit (OIB) |
| | Czech Republic | Czech Registry of Occupational Disease<br>http://www.szu.cz/publications-and-products/data-and-statistics/occupational |
| 1B | Denmark | Erhvervssygdomsregister (Occupational Disease Register) |
| | Finland | Finnish Register of Occupational Diseases (FROD) |
| | Hungary | Mandatory reporting and registration system of ODs<br>http://www.omfi.hu/ |
| | Switzerland | Statutory Health Surveillance for Occupational Diseases (SUVA) |
| | France | Régime Général (General Regime)<br>www.risquesprofessionnels.ameli.fr/statistiques-etanalyse/sinistralite-atmp.html |
| | Germany | DGUV German Statutory Accident Insurance<br>www.dguv.de/de/index.jsp |
| | Bulgaria | Occupational disease register |
| | Latvia | The National Registry of Occupational Diseases of Republic of Latvia |
| | South Korea | Workers' Compensation and Welfare Service (COMWEL) |
| | Belgium | Fonds voor de Beroepsziekten; Fund for Occupational Diseases<br>www.fmp-fbz.fgov.be/web/index |
| | Austria | Statistiek Berufskrankheiten; Occupational Diseases Statistics<br>http://www.auva.at/ |

| Type | Country | Name or description of system, website |
|---|---|---|
| 1C | Canada | National Work Injuries Statistics Program (NWISP)<br>http://awcbc.org/?page_id=10 |
| | Taiwan | Program to Reduce Exposure by Surveillance System — Work-related diseases (PRESS-WORD) |
| | USA<br>(3 sub-systems) | Safety & Health Assessment & Research for Prevention (SHARP) (three sub-systems concerning dermatitis, asthma and musculoskeletal disorders)<br>http://www.lni.wa.gov/Safety/Research/OccHealth/Derm/default.asp<br>http://www.lni.wa.gov/Safety/Research/OccHealth/Asthma/Surveillance.asp<br>http://www.lni.wa.gov/Safety/Research/Wmsd/Default.asp |
| 1C+ | Taiwan | Network of Occupational Disease and Injury Services (NODIS)<br>http://www.tmsc.tw/index.php |
| 2A | United Kingdom | The Health and Occupation Reporting Network for General Practitioners (THOR-GP)<br>www.coeh.man.ac.uk/u/thorgp |
| | United Kingdom and Ireland | Occupational Physicians Reporting Activity (OPRA)<br>www.coeh.man.ac.uk/u/opra<br>www.coeh.man.ac.uk/u/ire-opra |
| | Norway | Registry of Work-related Diseases (RAS); Register for Arbeidsrelaterte Sykdommer<br>http://www.arbeidstilsynet.no/artikkel |
| | Norway | National Institute of Occupational Health (NIOH) registry<br>https://stami.no/ |
| | France | Surveillance Programme of Work-related Diseases (MCP); Les maladies à caractère professionnel<br>Institut de veille sanitaire InVS — French Institute for Public Health Surveillance<br>http://www.invs.sante.fr/fr/Dossiersthematiques/Travail-et-sante/Maladies-a-caractere-professionnel |
| | Netherlands | National Occupational Diseases Registry (NODR)<br>ncvb.amc.nl/NCVB-MenR/dyn/user/login |
| | Netherlands | Surveillance Project for Intensive Notification (PIM); Peilstation Intensief Melden<br>http://www.occupationaldiseases.nl/ |
| | Spain | Occupational Health Surveillance Program in Navarre<br>http://www.navarra.es/home_es/Temas/Portal+de+la+Salud/Profesionales/Informacion+tecnica/Salud+laboral/sucesos+centinela.htm |
| | USA | Washington State Behavioral Risk Factor Surveillance System (BRFSS) — Worker Health Module<br>http://www.lni.wa.gov/Safety/Research/Projects/BRFSSWorkerHealth/default.asp |

| Type | Country | Name or description of system, website |
|---|---|---|
| | Sweden | Doctor's reporting of illness according to the Swedish Work Environment Authority's Statute Book (Arbetsmiljöverkets författningssamling, AFS) (Swedish Work Environment Authority, 2005) |
| | China | Occupational Disease Surveillance and Reporting System (ODSRS) |
| 2A+ | France | French National Occupational Diseases Surveillance and Prevention Network (RNV3P); Réseau National de Vigilance et de Prévention des Pathologies Professionnelles<br>www.anses.fr/fr?pageid=1671&parentid=943 |
| | United Kingdom | The Health and Occupation Reporting network-Extra (novel causes) (THOR-EXTRA) |
| | Italy | Malattie Professionali (MALPROF)<br>www.ispesl.it/statistiche/ |
| 2B | United Kingdom and Ireland | Surveillance of Work-related and Occupational Respiratory Disease (SWORD)<br>www.coeh.man.ac.uk/u/sword<br>www.coeh.man.ac.uk/u/ire-sword |
| | United Kingdom and Ireland | Occupational Skin Surveillance (EPIDERM)<br>www.coeh.man.ac.uk/u/epiderm<br>www.coeh.man.ac.uk/u/ire-epiderm |
| | United Kingdom | Surveillance of Infectious Diseases At Work (SIDAW)<br>http://www.population-health.manchester.ac.uk/epidemiology/COEH/research/thor/schemes/sidaw/ |
| | United Kingdom | Occupational Surveillance of Otorhinolaryngological Disease (THOR-ENT) |
| | United Kingdom | Musculoskeletal Occupational Surveillance Scheme for Rheumatologists (MOSS) |
| | United Kingdom | Occupational Surveillance Scheme for Audiological physicians (OSSA) |
| | United Kingdom | Surveillance of Occupational Stress and Mental Illness (SOSMI) |
| | United Kingdom | Rare Respiratory Disease Registry Surveillance Scheme of Occupational Asthma (SHIELD) http://www.occupationalasthma.com/shield.aspx |
| | South Africa | Surveillance of Work-related and Occupational Respiratory Diseases in South Africa (SORDSA)<br>http://www.nioh.ac.za/?page=occupational_allergies,_asthma_and_dermatitis&id=154 |
| | Australia | Surveillance of Australian workplace Based Respiratory Events (SABRE) |
| | Canada | Ontario Work-Related Asthma Surveillance System (OWRAS) |
| | Canada | Physician-based Surveillance System For Occupational Respiratory Diseases (PROPULSE) |
| | Canada | British Columbia Surveillance programme for occupational lung diseases |

| Type | Country | Name or description of system, website |
|---|---|---|
| | Spain | Voluntary registry of occupational respiratory diseases in Asturias, Catalonia and Navarre |
| | South Korea | Work-related Asthma Surveillance (KOWAS) programme |
| | France | Observatoire National des Asthmes Professionnels (ONAP2)<br>Institut de Veille Sanitaire InVS — French Institute for Public Health Surveillance InVS<br>http://www.invs.sante.fr/fr/Dossiersthematiques/Travail-et-sante/Asthme-d-origine-professionnelle |
| | France | French registry of workers handling engineered nanomaterials (EPINANO)<br>Institut de Veille Sanitaire InVS — French Institute for Public Health Surveillance InVS<br>http://www.invs.sante.fr/Dossiers-thematiques/Travail-et-sante/Epinano-Dispositif-de-surveillance-epidemiologique-des-travailleurs-potentiellement-exposes-aux-nanomateriaux |
| | Italy | Italian Occupational Cancer Monitoring Information System (OCCAM)<br>http://www.occam.it/en/ |
| 2C | United Kingdom | Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR)<br>www.hse.gov.uk/riddor/index.htm |
| | Singapore | iReport one-stop reporting platform for occupational accidents, injuries and diseases<br>http://www.mom.gov.sg/workplace-safety-and-health/work-accident-reporting |
| 3A | USA | Sentinel Event Notification System for Occupational Risks (SENSOR)<br>http://www.cdc.gov/niosh/topics/surveillance/ |
| | USA | Health Hazard Evaluation (HHE)<br>http://www.cdc.gov/niosh/hhe/hheprogram.html |
| 3A+ | Netherlands/Belgium | Signalering Nieuwe Arbeidsgerelateerde Aandoeningen Loket (SIGNAAL) |
| | France | Occupational Health Warning Group (GAST); Groupe d'alerte en Santé Travail<br>Institut de Veille Sanitaire InVS — French Institute for Public Health Surveillance InVS<br>http://www.invs.sante.fr/fr/Dossiers-thematiques/Travail-et-sante/Alertes-en-sante-travail |
| | France/ International | OccWatch<br>https://occwatch.anses.fr/ |
| 3A+ | New Zealand | Notifiable Occupational Disease System (NODS)<br>http://www.business.govt.nz/worksafe/notifications-forms/nods |

| Type | Country | Name or description of system, website |
|---|---|---|
| 3B | USA (2 sub-systems) | Sentinel Event Notification System for Occupational Risks (SENSOR) — two sub-programs on Pesticides Program and Work-related Asthma<br>http://www.cdc.gov/niosh/topics/pesticides/overview.html<br>http://www.cdc.gov/niosh/topics/surveillance/ords/statebasedsurveillance/wra.html |
| | New Zealand (4 sub-systems) | Four Panels (Cancer Panel, Respiratory Diseases Panel (The former Asthma and Asbestos Panels), Solvents Panel, Chemical Panel)<br>http://www.dol.govt.nz/publications/nohsac/occupational/004_content.asp |
| 4A | United Kingdom | Self-reported Work Related Illness survey (SWI) (module of the Labour Force Survey (LFS)<br>www.hse.gov.uk/statistics/publications/swi.htm |
| | Ireland | Quarterly National Household Survey (QNHS)<br>http://www.cso.ie/en/qnhs/ |
| 4B | France | Programme de Surveillance des Troubles Musculo-squelettiques (TMS)<br>Institut de Veille Sanitaire InVS — French Institute for Public Health Surveillance InVS<br>http://www.invs.sante.fr/fr/Dossiers-thematiques/Travail-et-sante/Troubles-musculo-squelettiques-TMS |
| | France | French National Program for Mesothelioma Surveillance (PNSM)<br>Institut de Veille Sanitaire InVS — French Institute for Public Health Surveillance InVS<br>http://www.invs.sante.fr/fr/Dossiers-thematiques/Travail-et-sante/Declaration-obligatoire-des-mesotheliomes |
| | USA | Pesticide Illness Surveillance Program (PISP) |
| | USA | Melioidosis Surveillance System |
| | Ireland | Notification by clinicians and hospitals on infectious diseases<br>http://www.hpsc.ie/NotifiableDiseases/NotifyingInfectiousDiseases/ |

## 3.2 Availability of data and selection of systems

Appendix B contains a list of all the systems identified in the literature review. The number of data we could retrieve was not the same for all the systems. Some of the systems were thoroughly described in the corresponding available references, whereas for others we could only find the basic information. Bearing in mind the large number of identified systems and the lack of available information for several systems, we reduced the list of systems to be described in the literature review, using the following exclusion criteria:

- systems that are not good examples for detecting new/emerging WRDs;

- systems for which most information is unavailable;
- systems that have been replaced by a new or improved version.

Upon applying these criteria, we excluded 25 systems (Table 6) and included 50 systems (Table 7) in the further analysis. The systems that were excluded were mostly compensation-based systems from the first group that did not provide relevant information on new WRDs and are thus not of interest for the scope of this review.

**Table 6: List of 25 systems excluded from the report**

| Category | Excluded systems |
|---|---|
| Category 1: 13 systems | |
| 1A | Russian system, UK IIDB, IE OIB and CZ NR (4) |
| 1B | Denmark, FR Regime General, DE DGUV, BU, LV, KOR COMWEL, AT Statistiek Berufskrantheiten (7) |
| 1C | Canada NWISP, Taiwan PRESS WORD (2) |
| Category 2: 9 systems | |
| 2A | NO NIOH registry, USA Washington State, SE AFS, China ODSRS (4) |
| 2B | UK SHIELD, ES, CAN PROPULSE, CAN British Columbia, KOR KOWAS (5) |
| Category 3: 1 system | |
| 3B | SENSOR State-based Asthma Surveillance Program (1) |
| Category 4: 2 systems | |
| 4A | USA melioidosis, IE infectious diseases (2) |

Note: The number in parentheses at the end of each list is the total number of systems excluded in that category.

**Table 7: Typology of 50 systems described in report**

| Population | Surveillance | Related to compensation | List and/or open or no list at all | New/emerging health risks | Code |
|---|---|---|---|---|---|
| Workers (45) | Passive (34) | Workers' compensation (9) | List systems (1) | | 1A |
| | | | List + Open systems (4) | | 1B |
| | | | No list (4) | 1C+ (1) | 1C/1C+ |
| | | | **General/specific** | | |
| | | Non-compensation systems (25) | All WRDs (10) | 2A+ (3) | 2A/2A+ |
| | | | One or subset of diseases (13) | | 2B |
| | | | Diseases and injuries (2) | | 2C |
| | Active (0) | | | | |
| | Sentinel (11) | Non-compensation (11) | All WRDs (6) | 3A+ (4) | 3A/3A+ |
| | | | One or subset of diseases (5) | | 3B |
| General public including workers (5) | Active (2) | | All WRDs (2) | | 4A |
| | Passive (3) | | One or subset of diseases (3) | | 4B |

| Type | Country | Name or description of system |
|---|---|---|
| 1A | Spain | Comunicación de Enfermedades Profesionales en la Seguridad Social (CEPROSS); Occupational Diseases Registry of the Social Security System for occupational diseases of the official list approved by a Royal Decree, and Patologías no Traumáticas Causadas por el Trabajo (accidentes de trabajo) de la Seguridad Socia (PANOTRASTSS) (annex to the OD list to register non-traumatic health effects that may be considered ODs in the future, but are currently not) |
| 1B | Belgium | Fonds voor de Beroepsziekten; Fund for Occupational Diseases |
| | Hungary | Mandatory reporting and registration system of ODs |
| | Switzerland | Statutory Health Surveillance for Occupational Diseases (SUVA) |
| | Finland | Finnish Register of Occupational Diseases (FROD) |
| 1C | USA | 3 Safety & Health Assessment & Research for Prevention (SHARP) programmes:<br>- SHARP programme aimed at dermatitis |
| | | - SHARP programme aimed at asthma |
| | | - SHARP programme aimed at musculoskeletal disorders |
| 1C+ | Taiwan | Network of Occupational Disease and Injury Services (NODIS) |
| 2A | United Kingdom | The Health and Occupation Reporting Network for General Practitioners (THOR-GP) |
| | United Kingdom<br>And Ireland | Occupational Physicians Reporting Activity (OPRA) |
| | Norway | Registry of Work-related Diseases (RAS); Register for Arbeidsrelaterte Sykdommer |
| | France | Surveillance Programme of Work-related Disease (MCP); Les maladies à caractère professionnel<br>Institut de Veille Sanitaire InVS — French Institute for Public Health Surveillance |
| | Netherlands | National Occupational Diseases Registry (NODS) |
| | Netherlands | Surveillance Project for Intensive Notification (Peilstation Intensief Melden (PIM)) |

| Type | Country | Name or description of system |
|---|---|---|
| | Spain | Occupational Health Surveillance Program in Navarre |
| 2A+ | France | French National Occupational Diseases Surveillance and Prevention Network (RNV3P); Réseau National de Vigilance et de Prévention des Pathologies Professionnelles |
| | United Kingdom | The Health and Occupation Reporting Network-Extra (novel causes) (THOR-EXTRA) |
| | Italy | MALattie PROFessionali (MALPROF) |
| 2B | United Kingdom and Ireland | Surveillance of Work-related and Occupational Respiratory Disease (SWORD) |
| | United Kingdom and Ireland | Occupational Skin Surveillance (EPIDERM) |
| | United Kingdom | Surveillance of Infectious Diseases At Work (SIDAW) |
| | United Kingdom | Occupational Surveillance of Otorhinolaryngological Disease (THOR-ENT) |
| | United Kingdom | Musculoskeletal Occupational Surveillance Scheme for rheumatologists (MOSS) |
| | United Kingdom | Occupational Surveillance Scheme for Audiological physicians (OSSA) |
| | United Kingdom | Surveillance of Occupational Stress and Mental Illness (SOSMI) |
| | South Africa | Surveillance of Work-related and Occupational Respiratory Diseases in South Africa (SORDSA) |
| | Australia | Surveillance of Australian Workplace Based Respiratory Events (SABRE) |
| | Canada | Ontario Work-Related Asthma Surveillance System (OWRAS) |
| | France | Observatoire National des Asthmes Professionnels (ONAP2)<br>Institut de Veille Sanitaire InVS — French Institute for Public Health Surveillance InVS |
| | France | French registry of workers handling engineered nanomaterials (EPINANO) |

| Type | Country | Name or description of system |
|---|---|---|
| | | Institut de Veille Sanitaire InVS — French Institute for Public Health Surveillance InVS |
| | Italy | Italian Occupational Cancer Monitoring Information System (OCCAM) |
| 2C | United Kingdom | Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR) |
| | Singapore | iReport one-stop reporting platform for occupational accidents, injuries and diseases |
| 3A | USA | Sentinel Event Notification System for Occupational Risks (SENSOR) |
| | USA | Health Hazard Evaluation (HHE) |
| 3A+ | Netherlands/ Belgium | Signalering Nieuwe Arbeidsgerelateerde Aandoeningen Loket (SIGNAAL) |
| 3A+ | France | Occupational Health Warning Groups (GAST); Groupe d'alerte en santé travail<br>Institut de Veille Sanitaire InVS — French Institute for Public Health Surveillance InVS |
| 3A+ | France/International | OccWatch |
| 3A+ | New Zealand | Notifiable Occupational Disease System (NODS) |
| 3B | USA | Sentinel Event Notification System for Occupational Risks (SENSOR) — Pesticides Program |
| | New Zealand | 4 Panels:<br>- Cancer Panel |
| | | - Respiratory Diseases Panel (The former Asthma and Asbestos Panels) |
| | | - Solvents Panel |
| | | - Chemical Panel |
| 4A | United Kingdom | Self-reported Work Related Illness survey (SWI) (module of the Labour Force Survey (LFS)) |
| | Ireland | Quarterly National Household Survey (QNHS) |
| 4B | France | Programme de surveillance des troubles musculo-squelettiques (TMS) |

| Type | Country | Name or description of system |
|---|---|---|
| | | Institut de Veille Sanitaire InVS — French Institute for Public Health Surveillance InVS |
| | France | French National Program for Mesothelioma Surveillance (PNSM)<br>Institut de Veille Sanitaire InVS — French Institute for Public Health Surveillance InVS |
| | USA | Pesticide Illness Surveillance Program (PISP) |

## 3.3 Validation and collection of missing information

To retrieve the missing information regarding the systems to be further discussed, we contacted the corresponding authors or experts involved in the systems. We sent emails to all the authors/experts, providing them with the extracted information for the corresponding system and pointing out the missing information. They were asked to revise the extracted information as well as provide the missing information, if possible. In addition to retrieving additional data, this enabled us to validate the obtained information. As systems evolve and change over time, contacting the experts who are familiar with the current activity of the systems provided us with the most up-to-date information regarding the systems. Furthermore, through our email communication with experts, we discovered an additional French system designed for detecting new/emerging WRDs: *Groupe d'alerte en santé travail* (GAST) — Occupation Health Warning Group. Since this system is within the scope of this review of this review, we decided to add it to the existing list of systems and briefly describe it in the report. However, we were limited to information retrieved through personal communication with the corresponding expert. This system was categorised as a sentinel system covering all WRDs, aimed at detecting new/emerging WRDs (3A+) and is presented in the report together with other systems from this group (sentinel systems).

# 4 Compensation-based national systems

We identified 22 compensation-based national systems in the initial long list (Appendix B). After applying the exclusion criteria defined in Section 4.2, we chose to describe nine representative examples of the typology, focusing on the systems which are interesting from the perspectives of new/emerging WRDs in addition to compensation. These systems cover both European countries (Belgium, Finland, Hungary, Spain and Switzerland) as well as two countries from outside Europe (Taiwan and the USA).

Systems from this group mainly collect data for compensation purposes. However, some of them (e.g. the Swiss and Taiwanese systems) provide an additional dataset that is unrelated to compensation, but can initiate compensation processes of reported cases, if indicated. The Washington SHARP programme is related to compensation in the sense that it derives all its information through data mining in the Washington Workers' Compensation claims.

In general, the EU systems in this group were characterised by nationwide coverage and monitored all types of WRDs. The Washington SHARP programme, on the other hand, is a state-based system that monitors specific groups of WRDs (skin disorders, asthma and musculoskeletal disorders). As a general rule, self-employed workers were excluded from these monitoring schemes. In addition, all systems were gender-inclusive and some of them (in the EU) covered SMEs. However, as information on SME coverage was not available for all the systems, we cannot provide an exact estimation of the extent to which SMEs are included in compensation-based systems.

Cases were mainly reported by physicians, with some systems allowing employers, employees, trade union delegates, etc., to make claims. Reporting in all EU systems from this group was legally required, which was not the case outside the EU (Taiwan and the USA). In terms of data collection, most of the systems required similar information from the reporters (e.g. workers' gender, age, date and place of birth, occupational title and sector of professional activity, diagnosis, etc.). In most of the systems, exposure data were described by the reporter and additionally verified by specialists. In all systems, the work-relatedness of the cases was evaluated by the recognised authority (e.g. medical doctors from insurance bodies, occupational physicians, etc.) and suspected cases of new/emerging WRDs were mainly further investigated by experts. Reports were a common way of disseminating knowledge, but had a weak link with preventive workplace actions.

## 4.1 Main characteristics

Table 8 shows the main characteristics of the compensation-based systems, such as the name, country, institution maintaining the system, and data related to the coverage, including type of WRD reported, sectors/workers and information on the inclusion of SMEs. The systems presented in Table 8 have an 'open list' approach, which allows the monitoring of diseases of suspected work-related origin. Indeed, systems that compensate only ODs on a predefined list ('closed list') are not suitable for detecting new/emerging WRDs, and were therefore not selected. Although all the open list systems were not initially designed to alert and/or prevent, these systems are still good examples of how compensation-

based approaches can be used for detecting new/emerging ODs or WRDs. The Swiss and Taiwanese compensation schemes, for example, have two separate datasets: a dataset of compensated cases (Swiss National Insurance Fund — SUVA; and the National Labour Insurance scheme in Taiwan) and an additional system (Swiss Statutory Health Surveillance for Occupational Diseases; and Taiwanese Network of Occupational Disease and Injury Services (NODIS)) that collects data unrelated to compensation, but which may initiate further compensation of identified cases, if indicated. The objective of these additional systems is mainly the prevention and identification of new WRDs, in addition to compensation.

The reporting criteria, in particular the level of proof required to attribute the disease to workplace exposure, varied between systems. Belgian, Finnish, Hungarian and Swiss systems also allow compensation of ODs not included on the list, if proven to be work-related in nature.

In Hungary, a medically confirmed diagnosis, confirmed exposure and a confirmed link between disease and exposure are required. The criteria for each disease are not always meticulously set: experts decide on the basis of their experience, available scientific information and specialist expertise if required. In Finland, the occupational exposure needs to be the main cause of the disease and the probability of association between the exposure and the outcome needs to be proven. Similarly, in the case of Switzerland, diseases not on the list are compensated only if caused solely, or to a major degree, by occupational activity (requires evidence of a 75 % or more probability of causation). The Spanish system is specifically divided into the Occupational Diseases Registry of the Social Security System (CEPROSS), for ODs on the official list, and the annex to the occupational diseases list to register non-traumatic health effects that may be considered ODs in the future (PANOTRASTSS), for registration of non-traumatic health effects that could be considered ODs in the future but currently are not. However, this system does not cover those mental diseases that are not on the predefined list. In the Taiwanese NODIS, a claim can be filed without a prescribed list, under the condition that the reporter provides justification and relevant literature references to support the work-relatedness of the condition. The Washington Safety & Health Assessment & Research for Prevention (SHARP) systems are the only systems in this group that were established to monitor specific diseases: work-related skin disorders, asthma or musculoskeletal disorders. However, the Washington SHARP Musculoskeletal Disorders Program has not been active since 1999.

All compensation-based systems are nationwide, except for the Washington systems, which cover only workers employed within the state. The Finnish Register of Occupational Diseases is the only system that covers all economic sectors, including the self-employed and (insured) farmers. Of the four other EU systems selected, three exclude self-employed workers (Switzerland, Hungary and Belgium) and the systems in Belgium and Switzerland also exclude military personnel. The Swiss and Hungarian surveillance systems also cover SMEs.

**Table 8: Main characteristics of nine selected compensation-based systems**

| Type | Country (start date) | System | Organisation maintaining the system | Type of WRDs/ODs reported | Sectors/workers covered |
|---|---|---|---|---|---|
| 1A | Spain (1989) | CEPROSS (for ODs of the official list approved by a Royal Decree) and PANOTRASTSS (annex to the OD list to register non-traumatic health effects that may be considered ODs in the future but are not today) | Inspectorate of the Social Security System | All (excluding mental health conditions not on the prescribed list) | All (since 2003, includes self-employed) |
| 1B | Switzerland (1984) | Statutory Health Surveillance organised by Swiss Accident Insurance Fund (SUVA) | Swiss Accident Insurance Fund (SUVA) | All | Self-employed, military personnel excluded; SMEs included |
| 1B | Hungary (1996) | Mandatory reporting and registration system of occupational diseases | Office of the Chief Medical Officer (Department of Occupational Health) | All | Self-employed, armed forces excluded; SMEs included |
| 1B | Finland (1964) | Finnish Register of Occupational Diseases (FROD) | Finnish Institute of Occupational Health | All | Self-employed and insured farmers included |
| 1B | Belgium (2000) | Fund Occupational Diseases (FOD) | Fund Occupational Diseases | All | Self-employed, military personnel and some government officials excluded |
| 1C+ | Taiwan (2007) | Network of Occupational Diseases and Injuries Service (NODIS) | Center for Occupational Disease and Injury Services (CODIS) | All | Potentially all workers; SMEs not directly included |

| Type | Country (start date) | System | Organisation maintaining the system | Type of WRDs/ODs reported | Sectors/workers covered |
|---|---|---|---|---|---|
| 1C | USA — Washington (1994) | Safety & Health Assessment & Research for Prevention (SHARP) Dermatitis program | Washington State Department of Labor and Industries | Work-related skin disorders | Workers employed in the state of Washington |
| 1C | USA — Washington (2002) | Safety & Health Assessment & Research for Prevention (SHARP) Asthma Program | Washington State Department of Labor and Industries | Work-related asthma | Workers employed in the state of Washington |
| 1C | USA — Washington( 1991-1999) | Safety & Health Assessment & Research for Prevention (SHARP) Musculoskeletal Disorders Program | Washington State Department of Labor and Industries | Work-related musculoskeletal disorders | Workers employed in the state of Washington |

## 4.2 Report mechanism and data collection

**Table 9: Reporting and data collection in nine selected compensation-based systems**

| Type | Country (system) | Type of reporters | Reporting mechanism | Data collected | Information on exposure |
|---|---|---|---|---|---|
| 1A | Spain (CEPROSS and PANOTRASTSS) | Physicians, industrial hygienists, OSH practitioners, occupational nurses, employers, trade union delegates, employees | Obligatory, website/email | Worker's gender, date and place of birth, occupational title and sector of professional activity, address, workplace address, exposure, diagnosis | Described by reporting physician |
| 1B | Switzerland (SUVA) | Physicians | Obligatory, on paper/online tool | Worker's gender, date and place of birth, occupational title and sector of professional activity, address, | Additional verification by specialists |

| Type | Country (system) | Type of reporters | Reporting mechanism | Data collected | Information on exposure |
|---|---|---|---|---|---|
| | | | | workplace address, diagnosis, specific medical information | reporting/assessing the claim |
| 1B | Hungary (Mandatory reporting and registration system of ODs) | Physicians | Obligatory, on paper | Worker's gender, date and place of birth, occupational title and sector of professional activity, address, workplace address, duration of exposure, diagnosis, level of imputability, susceptibility | Described by reporting physician and checked by the HU-OSH inspection authority |
| 1B | Belgium (FOD) | Physicians, employees | Obligatory, on paper | Worker's gender, date of birth, age, occupation and sector of professional activity, workplace address, exposures, diagnosis, symptoms, level of imputability | Additional verification in cases when further health surveillance is indicated |
| 1B | Finland (FROD) | Physicians, employers | Obligatory, on paper | Worker's gender, age, date of birth, occupational title and sector of professional activity, address, workplace address, exposures, duration of exposure, diagnosis, symptoms, date of symptoms onset, susceptibility | Yes |
| 1C+ | Taiwan (NODIS) | Occupational physicians | Voluntary, online (website) | Worker's gender, age, industry and occupation, diagnosed disease(s), time of diagnosis, workplace exposure, hazards that caused the ailment | Described by reporter, based on careful details of working conditions, photographs of workplace, site inspection (in one-quarter of cases) |
| 1C | USA — Washington | Data mining from the workers' compensation database | Online (website) | Case information is extracted from the claims management system | No record |

| Type | Country (system) | Type of reporters | Reporting mechanism | Data collected | Information on exposure |
|---|---|---|---|---|---|
| | (SHARP-dermatitis) | | | | |
| 1C | USA — Washington<br>(SHARP-asthma) | Physician reporting and data mining from the workers' compensation database | Online (website) | Cases are interviewed by phone to collect additional data | Collected through interviews of cases |
| 1C | USA — Washington<br>(SHARP-musculoskeletal disorders) | Data mining from the workers' compensation database | Online (website) | Case information is extracted from the claims management system | No record |

Table 9 presents information on the reporting mechanism and data collection of the compensation-based systems: type of reporter, reporting mechanism (obligatory/voluntary and transfer of information), and data collected by the system. In addition, information on exposure assessment was collected, with the aim of distinguishing different levels of investigation, for example, whether it is only described by the reporter or additionally verified.

In some countries, such as Spain, Finland, Hungary and Belgium, the reporting of suspected WRDs/ODs is legally required for insurance or compensation purposes, whereas reporting in Taiwan and the state of Washington is based on voluntary participation. In the systems selected, physicians can report suspected cases in all compensation-based systems. Other specialists, such as industrial hygienists, can report in Spain. In the case of the systems in Spain and Belgium, workers can make a claim, and the Spanish systems also allow OSH practitioners, occupational nurses, employers and trade union delegates to report. In Switzerland, industrial hygienists and employees can make a compensation claim directly to the Swiss National Insurance Fund (SUVA), but only physicians who perform medical examinations of the workers can report suspected cases to the Statutory Health Surveillance for Occupational Diseases, regardless of whether or not further compensation is initiated. In Finland, physicians have the obligation to notify cases of occupational and work-related diseases to the Regional State Administrative Agencies. Additional reporting sources are the Farmers' Social Insurance Institution (MELA) and Federation of Accident Insurance Institutions (FAII). Whereas MELA collects notifications from farmers and physicians, FAII gathers reports from physicians and employers forwarded by Insurance companies. All notifications coming from these sources are forwarded to the Finnish Institute of Occupational Health (FIOH).

The Washington SHARP programme uses a specific data mining method, which reviews all Washington Workers' Compensation claims that have been encoded for occupational injury or illness. Washington is the only state in the USA in which the labour department has both a state Occupational Safety and Health Administration plan and a compensation system for its workers. This permits unique opportunities to use data from both programmes. In the SHARP Asthma Program, in addition to data mining, physicians are also a reporting source, and began reporting cases directly to SHARP in 2000, when work-related asthma was established as a reportable condition. Thus, in this system, cases are identified either through data mining or by the reporting physicians. After a case is identified, follow-up materials are mailed to the worker to whom the case refers. The material includes information about the surveillance programme and the claim, and educational materials on work-related asthma. Workers are also informed that they may be selected for a follow-up telephone interview to collect additional information on each case.

Many of the systems use online communication, whereas Switzerland, Hungary, Finland and Belgium still rely on paper forms.

In Taiwan, the Department of Health ran an old system (Program to Reduce Exposure by Surveillance System — Work-related diseases (PRESS-WORD)) (Wu et al., 1996) that collected paper forms issued by general practitioners and specialists from 1995 to 2007. This was then replaced by a new internet-based system (NODIS) (Chu et al., 2013). The reporters in the new system are specialists in occupational medicine.

## 4.3 Evaluation of work-relatedness and use of data

**Table 10: Evaluation of work relatedness and use of data in compensation-based systems**

| Type | Country (system) | Evaluation of work-relatedness | Feedback to reporter | Follow-up of new/emerging risk | Dissemination of results, link with prevention | Collection into a database |
|---|---|---|---|---|---|---|
| 1A | Spain (CEPROSS and PANOTRASTSS) | National Institute of Occupational Health | Not always | Yes, national and international expert group | Dissemination through reports; labour inspections | Yes (public) |
| 1B | Switzerland (SUVA) | Medical doctors of the insurance funds | Yes | Yes, expert group at insurance company | Dissemination through reports | No |
| 1B | Hungary | Medical doctors and work hygiene specialists of the Office of the Chief Medical Officer | Yes | Yes, national expert group | Annual report to the government, summary reports in scientific journals; possible link with prevention, depending on policy-makers' and stakeholders' interest | Yes (incomplete, not public) |
| 1B | Belgium (FOD) | Medical doctors from the insurance funds; possible consultation with expert commission on new occupational diseases | No | No | No | No |

| Type | Country (system) | Evaluation of work-relatedness | Feedback to reporter | Follow-up of new/emerging risk | Dissemination of results, link with prevention | Collection into a database |
|---|---|---|---|---|---|---|
| 1B | Finland (FROD) | Finnish Institute of Occupational Health, Team of experts in the Ministry of Social Affairs And Health | No | No | Publication of alert information | No |
| 1C+ | Taiwan (NODIS) | Three senior occupational physicians, using the same work-relatedness criteria | Yes | Yes, national expert group | Dissemination; initiates inspection and workplace improvement; initiates cluster investigation that can be followed by epidemiological investigation | Yes |
| 1C | USA — Washington (SHARP-dermatitis) | No record | No record | Yes | Dissemination, workplace interventions | No record |
| 1C | USA — Washington (SHARP-asthma) | No record | No record | Yes | Dissemination, workplace interventions | No record |
| 1C | USA — Washington (SHARP-musculoskeletal disorders) | No record | No record | Yes | Dissemination, workplace interventions | No record |

Table 10 contains data on work-relatedness evaluation, such as the evaluating committee and whether a reporter receives feedback on the work-relatedness decision. It also presents information on the follow-up of the reported case of new/emerging WRDs as well as data on the dissemination of results and preventive actions. Finally, we gathered information on the collection of reported cases into a database, and the availability of the database for public research.

When the collected data are used for the evaluation of possible new/emerging risk in the systems listed in Table 10, this is done by a group of experts. The composition of this group depends on the reporting system. In the case of the Spanish system, a research institute (National Institute of Occupational Health) is responsible for the evaluation. In Finland, all notifications gathered by different reporting sources are forwarded to the FIOH where the final decision on work-relatedness is made (Spreeuwers et al. 2010). In Switzerland and Belgium, the expert team consists of medical doctors from the insurance funds. In Belgium also, an expert commission on new ODs provides advice to the OD fund. In Hungary, the authorised organisation that makes the decision on work-relatedness is the Labour Inspectorate authority. In Taiwan, cases are referred to senior occupational physicians in one of the nine tertiary referral medical centres (Centers for Occupational Disease and Injury Services — CODISs), supported by the Council of Labor Affairs.

All systems, except that of Belgium and Finland, provide feedback to the reporter on work-relatedness. A mechanism for following up a possible new/emerging risk by a national/international expert group is in place in most of these systems. The Belgian and Finnish compensation-based systems have no follow-up mechanism on new/emerging risks, nor for any further implementation of preventive actions. However, there are now concrete plans to do so.

In the Swiss system, the detection of an increased incidence of a work-related disease can lead to workplace interventions aimed to prevent ill-health and protect co-workers. The Spanish system carries out follow-up inspections at the workplace through labour inspection, whereas the system in Taiwan implements health education as well as worksite investigations and interventions. In both the Swiss and Spanish systems, the information obtained is disseminated through reports.

The Washington SHARP systems use various methods of dissemination and prevention. SHARP fosters the sharing of information with health care providers, public health professionals and labour and industry stakeholders. In addition, the dissemination of educational information is a routine part of case follow-ups. Educational materials are sent to each identified case, after which a telephone interview is carried out to retrieve further information on the case and provide workers with adequate education regarding their work-related condition. As the main objective of this system is to identify high-risk occupations and industries and useful prevention strategies, case data are analysed periodically for clusters by industry and occupation, to help develop specific prevention strategies and recommendations. One of the examples is the prevention index (PI) that is used to help prioritise information for action. The PI is

constructed by rank ordering all industries by claims incidence rate and by incident count, and then averaging the two ranks as shown in equation 1.

PI = (Incidence rank + Count rank)/2) (1)

Different prevention strategies may be used depending on how an industry is ranked. For instance, data from the SHARP Asthma Program were used to identify industries with a potentially increased risk of asthma. A high incidence of work-related asthma was identified in the automobile collision repair industry. Collision repair in Washington State is a male-dominated industry composed chiefly of small, non-unionised, family-run businesses and had received very little OSH attention from the state. SHARP researchers, in collaboration with the industry association, were able to determine high diisocyanate absorption from respiratory and dermal exposures. This led to further research on different gloves. Workers' compensation claims continued to be monitored and different control measures were implemented (Marucci-Wellman et al., 2009).

The Spanish, Hungarian and Taiwanese systems collect cases of new/emerging WRDs in databases, whereas this is not the case in other systems in this group. The Spanish databases (CEPROSS and PANOTRASTSS) are used for research and allow other researchers access. In contrast, the Hungarian database does not serve research purposes and is closed to external researchers.

# 5 Non-compensation-related systems for data collection and statistics

We identified 34 non-compensation-related systems primarily designed for data collection and statistics in our long list (Appendix B). Based on the exclusion criteria specified in Section 3.2, we selected 25 representative systems, which will be described in the following sections.

This category groups together the largest number of systems identified in the literature review and includes a large number of European countries (the United Kingdom, Ireland, Italy, Norway, France, the Netherlands and Spain) and several additional countries (South Africa, Australia, Canada and Singapore). A common feature of these systems is that they were designed with the aim of improving the collection and analysis of data to measure trends in occupational and work-related diseases. Therefore, these systems are mostly maintained by national occupational or public health institutes. Although some of them have a broad scope that covers all work-related or occupational diseases (2A), others aim to monitor a specific subset of such diseases (2B), or work-related injuries, accidents and diseases (2C). Three systems (MALPROF in Italy, the Health and Occupation Research Network (THOR)-EXTRA in the United Kingdom and Ireland, and the National occupational illness surveillance and prevention network (RNV3P) in France) aim to identify new/emerging work-related health problems (2A+).

Generally, these systems have a nationwide scope, with a few exceptions that cover certain geographical areas (e.g. Italian MALPROF covers 14 out of 20 Italian regions, and the Occupational Health Surveillance Program in Navarre monitors this specific region). All the systems cover both genders and approximately half of them report covering SMEs. Certain sectors, such as civil servants, military and police sectors, and the self-employed are excluded by some schemes.

The majority of the systems for monitoring a specific group of WRDs were designed to collect information on work-related respiratory diseases. However, most of the systems specific to respiratory diseases no longer collect data and the UK Surveillance of Work-related and Occupational Respiratory Disease (SWORD) programme (part of THOR) remains the only currently active system. In addition, we identified schemes for monitoring work-related skin diseases, occupational cancer, work-related infectious diseases and diseases related to occupational exposure to nanomaterials. Moreover, UK THOR maintained additional schemes for work-related otorhinolaryngological disorders (THOR-ENT), musculoskeletal disorders (MOSS), audiological disorders (OSSA) and mental ill-health (SOSMI) — but these are no longer active.

Unlike compensation-based systems, both obligatory and voluntary reporting of cases are present in the group of non-compensation-related systems. Reporting in this group is mainly done by physicians, whereas in systems for monitoring all WRDs, it is mostly done by occupational physicians or general practitioners; and in the systems aimed at specific groups of WRDs, by specialists (such as dermatologists for work-related skin diseases, pulmonologists or allergists in the case of work-related respiratory diseases, etc.). Employers and employees can report only in the two systems that monitor occupational injuries and accidents (2C). In addition, these two systems allow the reporting of WRDs,

accidents and injuries that are on the prescribed list. While reporting is spontaneous in all the systems monitoring all WRDs (2A), a common practice in the 2B group (aimed at a group of WRDs) was a specific reporting principle (e.g. physicians report monthly or report all new diagnosed cases for a randomly selected month each year). In addition to physician reporting, some systems use different approaches for collecting data: for example, the French RNV3P and Italian OCCAM programmes perform data mining, whereas the French Registry of Workers Handling Engineered Nanomaterials (EpiNano) forms prospective cohort studies that include workers exposed to nanomaterials. Data collected when reporting cases usually include information on the worker's gender, age, occupational title and sector of professional activity, exposures and diagnosis. Furthermore, some systems request additional data on the work-related disease, such as information on the onset of symptoms, susceptibility and level of imputability. When gathering data on exposure, these systems generally rely on the reporting physicians, who describe the suspected exposure together with the other data while reporting cases. The exception to this rule is EpiNano, which includes onsite exposure data collection using a standardised questionnaire.

In terms of the evaluation of work-relatedness, we identified two different approaches. One group of systems relies on the decision made by the reporting physician with no further investigation (mostly systems from the 2B group for monitoring work-related respiratory diseases). Furthermore, these systems provide no follow-up of suspected cases of new/emerging WRDs. In other systems, the final decision on work-relatedness is made by experts from the acknowledged authority (usually the research centre that maintains the system). This is mostly accompanied by a follow-up of cases. Only the French RNV3P and French Institute for Public Health Surveillance (InVS) systems have a specific group of experts on new/emerging work-related diseases.

International papers, symposia and websites are the usual means of disseminating the information and knowledge gathered by the systems. The French RNV3P programme uses several levels of dissemination, including an internal alert to clinicians in the RNV3P network, a search for similar cases outside the network and diffusion to authorities to begin necessary actions. In most other cases, the link with prevention is weak: only two systems perform labour inspections to implement necessary preventive actions (UK THOR and Norwegian Registry of work-related diseases (RAS)); and the EpiNano aims to identify problems and improve the safety of work stations with high exposure potential for nanomaterials. Most of the systems record cases of suspected new/emerging WRDs in a database, some of which are used for research purposes, and are available to external researchers.

## 5.1 Main characteristics

Table 11 presents the main characteristics of non-compensation-related systems, such as the name of the system, its country, and the institution that maintains the system. The table contains information on the coverage of the systems, in terms of both type of WRD and the economic sectors covered by the systems, including information on SMEs.

**Table 11: Main characteristics of non-compensation-related systems primarily designed for data collection and statistics**

| Type | Country (start date) | System | Organisation maintaining the system | Type of WRDs/ODs reported | Sectors/workers covered |
|---|---|---|---|---|---|
| **2A** (THOR-GP, OPRA)<br>**2B** (SWORD, EPIDERM, SIDAW)<br>**2A+** (THOR-EXTRA) | United Kingdom and Ireland (1989) | • THOR-GP<br>• OPRA<br>• SWORD<br>• EPIDERM<br>• SIDAW<br>• THOR-EXTRA | Centre of Occupational and Environmental Health (COEH), University of Manchester | Depending on the scheme:<br>THOR-GP, OPRA: all;<br>SWORD: respiratory WRD;<br>EPIDERM: skin WRD;<br>SIDAW: infectious WRD;<br>THOR-EXTRA: WRD with a novel cause | No record |
| 2A+ | Italy (2000) | MALattie PROFessionali (MALPROF) | National Institute for Insurance against Accidents at Work (INAIL) | All | 14 of 20 Italian regions (80 % of workers); SMEs included |
| 2A | Norway (1987) | Registry of work-related diseases<br>Register for Arbeidsrelaterte Sykdommer (RAS) | Labour inspectorate | All | Off-shore petroleum, aviation and marine sectors excluded (covered by another system); SMEs included |

| Type | Country (start date) | System | Organisation maintaining the system | Type of WRDs/ODs reported | Sectors/workers covered |
|---|---|---|---|---|---|
| 2A | France (2003) | Surveillance programme of Work-Related Diseases (MCP) | French Institute for Public Health Surveillance (InVS) | All | 11 out of 18 French regions; civil servant, military, education, and police sectors excluded |
| 2A | The Netherlands (1997) | • National Occupational Disease Registry (NODR)<br>• Surveillance Project for Intensive Notification Peilstation Intensief Melden (PIM) | Netherlands Center for Occupational Diseases (NCOD) | All | Temporary employed and self-employed excluded; SMEs included |
| 2A | Spain (1998) | Occupational Health Surveillance Program in Navarre | Instituto Navarro de Salud Laboral (INSL) | All | Navarre; SMEs included |
| 2A+ | France (2001) | French National Occupational Diseases Surveillance and Prevention Network<br><br>Réseau national de vigilance et de prévention des pathologies professionnelles (RNV3P) | The French Agency for Food, Environmental and Occupational Health & Safety | All | All 32 centres de consultation de pathologie professionnelle (CCPP) in France |

| Type | Country (start date) | System | Organisation maintaining the system | Type of WRDs/ODs reported | Sectors/workers covered |
|---|---|---|---|---|---|
| 2B | France (2013) | French registry of workers handling engineered nanomaterials (EpiNano) | French Institute for Public Health Surveillance (InVS) | WRDs related to nanomaterial exposure | Employees in companies using or producing engineered nanomaterials (ENM) (pre-selection); SMEs included |
| 2B | South Africa (1996 — not active since 2006) | Surveillance of Work-related and Occupational Respiratory Diseases in South Africa (SORDSA) | National Centre for Occupational Health, South African Pulmonology Society (SAPS), South African Society for Occupational Medicine (SASOM), South African Society for Occupational Health Nurses (SASOHN) and the Department of Labour | Work-related and occupational respiratory diseases | Non-mining sector and ex-miners |
| 2B | Australia (1997; scheme not active in New South Wales (NSW) since 2008) | Surveillance of Australian workplace Based Respiratory Events (SABRE) | Workers' Compensation (Dust Diseases) Board of NSW and Monash University Melbourne Australia | Work-related and occupational respiratory diseases | Very variable — only those referred to occupational physicians and respiratory physicians; no systematic reporting |
| 2B | Canada-Ontario (2007 — no longer active) | Ontario Work-Related Asthma Surveillance System (OWRAS) | No record | Work-related asthma, work-related bronchitis, rhinitis or skin changes | Ontario; all sectors |

| Type | Country (start date) | System | Organisation maintaining the system | Type of WRDs/ODs reported | Sectors/workers covered |
|---|---|---|---|---|---|
| 2B | France (2008 — not active since 2014) | Programme for surveillance of professional asthma (ONAP2) | French Institute for Public Health Surveillance (InVS) | Work-related asthma | All sectors |
| 2B | Italy (2000) | Italian Occupational Cancer Monitoring Information System (OCCAM) | National Institute for Occupational Health (ISPESL), Italian National Cancer Institute in Milano | Occupational cancer | Various groups of workers/economic sectors and geographic regions in different case-control studies |
| 2C | United Kingdom (1996) | Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR) | No record | Prescribed list | No record |
| 2C | Singapore (2006) | iReport; one-stop reporting platform for occupational accidents, injuries and diseases | Ministry of Manpower (MOM) | Prescribed list | Independent contractors, self-employed, domestic workers and uniformed personnel excluded |

### 5.1.1 Complex systems with several monitoring schemes

THOR (Money et al., 2015) is a UK-wide surveillance network run by the Centre of Occupational and Environmental Health of the University of Manchester. It was initiated in the United Kingdom in the late 1980s and later extended to Ireland. It comprises a number of surveillance schemes, of which the first three are also implemented in Ireland:

- SWORD (Surveillance of Work-Related and Occupational Respiratory Disease) (since 1989) (McDonald et al., 2005);
- EPI-DERM (work-related and occupational skin disease) (since 1993) (McDonald et al., 2006);
- SIDAW (Surveillance of Infectious Diseases At Work) (since 1996);
- OPRA (Occupational Physicians Reporting Activity) (since 1996) (Meyer et al., 2002);
- THOR-GP (reporting scheme for general practitioners with training in occupational medicine) (since 2005);
- THOR- EXTRA (system for reporting an interesting case or novel cause of WRD).
    - THOR-EXTRA is a scheme specifically designed for detecting new/emerging WRDs. As stated in the THOR reporting guidelines, the main indicators for reporters to use THOR-EXTRA are the following:
    - (1) If they see a new incident case of occupational disease or work-related ill-health that is outside their randomly selected reporting month (in other THOR schemes, specialists report during one randomly selected month per year), but which they feel merits reporting for special reasons (e.g. a possible new cause of occupational disease).
    - (2) If they have already submitted a new incident case but wish to provide additional,
    - supplementary information.
    - This way, THOR-EXTRA provides a platform for new/emerging WRD detection by all physicians participating in the THOR monitoring system, regardless of their specialty and scope of practice.

Four schemes aimed at specific subsets of diseases collected data under THOR for several years, but are no longer active:

- THOR-ENT (Occupational Surveillance of Otorhinolaryngological Disease) (2005-2006);
- MOSS (Musculoskeletal Occupational Surveillance Scheme for rheumatologists) (1997-2009);
- OSSA (Occupational Surveillance Scheme for Audiological physicians) (1997-2006);
- SOSMI (Surveillance of Occupational Stress and Mental Illness) (1999-2009).

Another complex surveillance system consisting of several schemes is run by the InVS (Carder et al., 2015; Valenty et al., 2015). This organisation coordinates one system for all WRDs (that are not compensated in other schemes) — the Surveillance programme of Work-Related Disease (MCP) — as well as three schemes for specific groups of WRDs: the programme for surveillance of professional asthma (ONAP2), the programme for the surveillance of musculoskeletal problems (TMS) and the French National Program for Mesothelioma Surveillance (PNSM). TSM and PNSM monitor both work-related and non-work-related cases and will thus be described as part of the fourth group of systems explored in this report (see Section 7: Public Health Surveillance of workers and non-workers).

### 5.1.2 Registries and national systems for monitoring all work-related or occupational diseases

These systems are mainly nationwide (with the exception of Navarre, which is a regional monitoring scheme) and are characterised by a wide coverage of economic sectors. However, in some of the systems, certain groups, such as civil servants, military and police personnel, and the self-employed, are excluded. Most of the systems for monitoring all ODs or WRDs reported that they cover SMEs.

The Italian professional diseases programme (MALPROF) (Campo et al., 2015) derives from the collaboration of Italian regions and the research department of the National Institute for Insurance against Accidents at Work (INAIL), and currently covers 14 out of 20 Italian regions (around 80 % of the working population). It began with the aim of monitoring and controlling WRDs and identifying new diseases not yet recognised as work related.

The Norwegian RAS system (Samant et al., 2008) is a national registry run by the Labour Inspectorate. Interestingly, this system is the only registry designed on the principle of SHEs, meaning that it provides a signal to the Norwegian Labour Inspectorate to begin workplace interventions and prevent hazardous exposure. As the main purpose of this system is data collection and analysis, it was categorised into this group. As regards the coverage of the system, the off-shore petroleum, aviation and marine sectors are not included in the monitoring; they are covered by another surveillance scheme. SMEs are included in RAS.

In the Netherlands, the collection of occupational disease data is mainly carried out by the Netherlands Center for Occupational Diseases (NCOD), which runs the National Occupational Disease Registry (Van der Laan et al., 2009). In 2009, NCOD started the Surveillance Project for Intensive Notification (PIM), which aims to provide additional data from a specific group of motivated occupational physicians. All economic sectors (including SMEs) are covered by this system, except for temporarily employed and self-employed workers.

The Spanish Occupational Health Surveillance Program in Navarre is the only regional surveillance system to monitor any type of WRD. Even though this is a regional system, its monitoring scheme covers all economic sectors, including SMEs.

The French RNV3P programme (Bonneterre et al., 2008, 2010, 2012) is the national network for surveillance and prevention of ODs, coordinated by ANSES (the French Agency for Food, Environmental and Occupational Health and Safety). This network is composed of all French Occupational Diseases Consultation Centres (CCPPs) (one in each university hospital, with two exceptions), and more recently of nine occupational health service units. Its main missions are to:

- describe occupational risk situations from an OD perspective;
- identify new aetiologies and emerging risks;
- promote a surveillance strategy of occupational risks;
- identify the areas in which prevention actions should be focused.

Finally, two systems monitor work-related injuries, accidents and diseases: the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR) system (United Kingdom) (Drummond, 2008) and iReport (Singapore) (Siang and Tan, 2010), a one-stop reporting platform for occupational accidents, injuries and diseases. Both systems allow the reporting only of work-related injuries, accidents and diseases included in the prescribed list. In the case of RIDDOR, the list of reportable ODs includes carpal tunnel syndrome, cramp of the hand or forearm, occupational dermatitis, hand-arm vibration syndrome, occupational asthma, and tendonitis or tenosynovitis. The iReport system allows the reporting of 30 ODs, including chemical poisoning, barotrauma, compressed air illness, epitheliomatous ulceration, occupational skin diseases, liver angiosarcoma, mesothelioma, noise-induced deafness, occupational asthma, repetitive strain disorder of the upper limb, silicosis, toxic anaemia and toxic hepatitis.

### *5.1.3 Systems aimed at specific groups of work-related diseases*

Five systems monitor work-related **respiratory diseases.** The UK SWORD programme (part of the THOR monitoring system) was the first system set up to monitor work-related respiratory diseases, initiated in 1989, and three other systems outside Europe were designed on its basis: Surveillance of Work-related and Occupational Respiratory Diseases in South Africa (SORDSA) (Hnizdo et al., 2001), Surveillance of Australian workplace Based Respiratory Events (SABRE) (Hannaford-Turner et al., 2010) and the Ontario Work-Related Asthma Surveillance System (OWRAS) (To et al., 2011). OWRAS is the third attempt to establish this kind of system in Canada, after The British Columbia Registry (Contreras et al., 1994) and PROPULSE in Quebec (Provencher et al., 1997) (both modelled on SWORD), both of which were implemented in the early 1990s. However, all three systems failed to progress beyond their pilot phase due to low participation rates. The Australian SABRE programme was initiated in 1997 in Victoria and in 2001 in New South Wales (NSW). However, the notification system in NSW ceased to operate in 2008 because of ethical issues in the Workers' Compensation (Dust Diseases) Board. The principal investigators resigned because the system showed poor compliance with the Human Research Ethics Committee's requirements, and the scheme is no longer in operation. The Thoracic Society of Australia and New Zealand has called for a centralised reporting scheme that works independently from compensation agencies and that is identical for each state, but to date no funding has been available for this scheme. Occupational lung diseases are still reported by the SABRE scheme in Victoria (Monash University), but there is a lack of information on the rest of Australia. ONAP2 is a work-related asthma monitoring scheme, one of the surveillance programmes maintained by the InVS. ONAP2 started in 2008, but stopped collecting data in 2014. The limited duration of all of these systems, with the exception of SWORD, the only scheme remaining active, illustrates how difficult it is to maintain such a system.

The only system monitoring work-related **skin diseases** is the UK EPIDERM, one of the monitoring schemes under the THOR surveillance system. Similarly, SIDAW, another THOR surveillance programme, is a single monitoring scheme for **infectious diseases** of work-related origin.

EpiNano (Boutou-Kempf et al., 2011) is a uniquely designed epidemiological surveillance system of workers **likely to be exposed to engineered nanomaterials**. Alerted by the possible impact of nanomaterial exposure on human health, the French Ministries of Health and of Labour have given the InVS the task of designing the protocol for this programme and initiating its pilot phase in 2013. This system monitors employees in companies across France who are known to use or produce engineered nanomaterials (ENM).

The Italian Occupational Cancer Monitoring Information System (OCCAM) (Crosignani et al., 2006) is the only non-compensation-related system specifically in place for monitoring **occupational cancer**. It was initiated after discrepancies were observed between the number of officially reported cases of occupational cancer and the number that could be expected on the basis of epidemiological estimates. Thus, this system was developed to find these 'lost OD cases', and covers various groups of workers, economic sectors and geographic regions in different programmes.

Even though stress at work is considered one of the main emerging risks and a priority of OSH prevention strategies, we identified no active systems specifically for monitoring work-related **mental illnesses**. Between 1999 and 2009, the Surveillance of Occupational Stress and Mental Illness (SOSMI) under the UK THOR programme collected data on occupational stress and mental illness reported by consultant psychiatrists. However, psychiatrists' data collection ended in 2009, and data on work-related mental ill-health are now collected from occupational physicians reporting to OPRA and from general practitioners reporting to THOR-GP. Approximately 40 % of the cases reported to OPRA and 39 % of the cases reported to THOR-GP concern mental ill-health. These data illustrate the prominence of stress and mental illness in work-related ill-health, and emphasise the need for greater knowledge regarding these illnesses, which could help provide improved working conditions for future prevention.

## 5.2 Reporting mechanism and data collection

Table 12 presents information regarding reporting mechanisms and data collection in non-compensation-related systems. This includes data on the type of reporter, whether reporting is obligatory or voluntary and the data transfer mechanism of the reported case. An additional column describing the frequency of reporting is provided as several systems in this group report on specific time intervals. The table also displays the data collected by the system and the means of gathering information on exposure. In the following sections, these systems are grouped and described according to the different data collection mechanisms.

**Table 12: Reporting and data collection in non-compensation-related systems primarily designed for data collection and statistics**

| Reporting mechanism and data collection type | Country (system) | Type of reporter | Reporting mechanism | Frequency of reporting | Data collected | Information on exposure |
|---|---|---|---|---|---|---|
| 2A/2B/2A+ | United Kingdom and Ireland<br><br>(THOR) | OPRA, occupational physicians; THOR-GP, general practitioners; SWORD, chest physicians; EPIDERM, dermatologists; SIDAW, infectious disease specialists; THOR-EXTRA, physicians | Voluntary, online form (website) | SWORD, EPIDERM, OPRA: monthly by a 'core' group of reporters; the remaining specialist 'sample' reporters report for one month per year randomly assigned;<br><br>SIDAW: monthly | Worker's gender, age, date of birth, occupational title and sector of professional activity, exposures, diagnosis, date of symptoms onset | Described by reporting physician |
| 2A+ | Italy<br><br>(MALPROF) | Physicians (e.g. companies'/Azienda Sanitaria Locale –Local Health Department (ASL) occupational physicians, INAIL insurance physicians, | Obligatory, on paper | Spontaneous | Worker's gender, age, date and place of birth, occupational title and sector of professional activity, diagnosis | Obtained indirectly from work history: nature of activity and economic sector, limited to duration of period for which worker is |

| Reporting mechanism and data collection type | Country (system) | Type of reporter | Reporting mechanism | Frequency of reporting | Data collected | Information on exposure |
|---|---|---|---|---|---|---|
| | | general practitioners, hospital specialists) | | | | supposed to have been exposed |
| 2A | Norway (RAS) | Physicians | Obligatory, on paper/email | ▪ Spontaneous | Worker's gender, age, date of birth, occupational title and sector of professional activity, address, workplace address, exposures, diagnosis | Coded according to causal agents of EODS* based on information sent by reporter |
| 2A | France (MCP) | Occupational physicians | Voluntary | Physicians report for a two-week period every six months | Worker's gender, age, occupational title and sector of professional activity, exposures, diagnosis, symptoms, date of onset of symptoms | Described by reporting physician |
| 2A | The Netherlands | NODR, occupational physicians; PIM, selected occupational physicians | NODR, obligatory; PIM, voluntary participation in the project, but obligatory reporting | Spontaneous | Worker's gender, age, occupational title and sector of professional activity, exposures, diagnosis, symptoms | Described by reporting physician |

| Reporting mechanism and data collection type | Country (system) | Type of reporter | Reporting mechanism | Frequency of reporting | Data collected | Information on exposure |
|---|---|---|---|---|---|---|
| 2A | Spain — Navarre | Physicians | Voluntary online (website) | Weekly | Administrative information on the patient, diagnosis, occupation, economic sector, whether co-workers experience similar pathology, work absence | Additionally assessed from information obtained from companies |
| 2A+ | France (RNV3P) | Occupational physician reporting and data mining | Obligatory for monitoring part, voluntary for new/emerging diseases; on paper | Spontaneous | Worker's gender, age, date and place of birth, occupational title and sector of professional activity related to principal exposure, address, workplace address, principal exposure and other possible exposures, principal disease and comorbid diseases, level of imputability | Exposures are usually described qualitatively by the reporter (sometimes atmospheric measurements are suggested or already available) |
| 2B | France (EpiNano) | Occupational physicians and/or safety and health engineers | Voluntary participation of companies, onsite visit of participating companies by the EpiNano occupational hygienist and | Not applicable | Past occupational history including specific exposure for each job, items on health status and anamnesis, life-style and habits such as smoking, alcohol consumption and physical activity | Onsite ENM exposure data collection using standardised questionnaire |

| Reporting mechanism and data collection type | Country (system) | Type of reporter | Reporting mechanism | Frequency of reporting | Data collected | Information on exposure |
|---|---|---|---|---|---|---|
| | | | epidemiologist; individual standardised questionnaire sent to workers eligible for inclusion in the EpiNano programme | | | |
| 2B | South Africa (SORDSA) | Pulmonologists, occupational medicine specialists, occupational health nurses from workplace health services (report cases diagnosed by doctors) | Voluntary, reporting forms (based on the SWORD form) and active data collection by phone, monthly | All new diagnosed cases reported for a randomly selected month each year | Disease, industry and job in which the exposure occurred and the putative causative agent; a more detailed form for each case of occupational asthma collected, further information including the method of diagnosis and history of the patient (includes guidelines for diagnosis) | Described by reporting physician |

| Reporting mechanism and data collection type | Country (system) | Type of reporter | Reporting mechanism | Frequency of reporting | Data collected | Information on exposure |
|---|---|---|---|---|---|---|
| 2B | Australia (SABRE) | Occupational physicians, respiratory physicians and general practitioners | Voluntary, reporting forms (based on the SWORD form) | All newly diagnosed cases reported for two randomly selected months each year | Worker's gender, smoking history, present occupation and occupation thought to have caused the disease (if different), industry, company address, presumed agent and diagnosis (absence of diagnostic criteria) | Described by reporting physician |
| 2B | Canada — Ontario (OWRAS) | Pulmonologists, occupational physicians, allergists or other physicians with an interest in occupational diseases | Voluntary, telephone/postal service/email | Monthly | Worker's initials, year of birth, current occupation or occupation related to disease reported, suspected exposure(s); symptoms (wheezing, chest tightness, and/or cough), smoking status, whether a claim has been submitted for compensation (diagnostic definitions available) | Described by reporting physician |
| 2B | France (ONAP2) | Pulmonologists and specialised physicians working in occupational health departments of | Voluntary, on paper | Spontaneous | Worker's gender, age, date and place of birth, occupational title and sector of professional activity, address, workplace address, exposures, diagnosis, symptoms, level of imputability | Described by reporting physician and additionally validated by experts |

| Reporting mechanism and data collection type | Country (system) | Type of reporter | Reporting mechanism | Frequency of reporting | Data collected | Information on exposure |
|---|---|---|---|---|---|---|
| | | university hospitals | | | | |
| 2B | Italy (OCCAM) | Data mining | Identification of 'cases' through Italian Cancer Registries or regional hospital discharge records and 'controls' through electronic population files | Not applicable | Medical data from cancer registries/regional hospital discharge records; Employment histories obtained by automatic linkage to social security (INPS) files | An individual is considered 'exposed' to a given industrial sector if he/she has worked for a company in that sector for at least a year |
| 2C | United Kingdom (RIDDOR) | Employers and self-employed persons | Obligatory; telephone/online form (website) | Spontaneous | Information on employee, workplace, incident, injured person; questions about injury, one free text question about accident | No record |
| 2C | Singapore (iReport) | Physicians, employers, employees | Obligatory, online one-step platform | Spontaneous | Demographic characteristics and administrative information on patient, details on occupational disease, exposure | Yes |

*'Eurostat Working Paper series, Population and social conditions 3/2000/E/n°18 — Classification of the causal agents of the occupational diseases (in all official European languages) — EODS' (Pascalicchio, 2000)

### 5.2.1 Data collection in reporting-based systems

The data collection in most of the systems described in Table 10 is based on case reporting by different types of reporters. The main group of reporters are physicians since they can report in all systems. Occupational physicians report in the Netherlands register, the French InVS (all schemes) and the UK THOR programme, which collects its data specifically from occupational specialists, that is the OPRA programme. In the French RNV3P system, any physician who finds a suspected work-related disease or even symptoms with no definite diagnosis that may be associated with work can refer the case to one of the occupational diseases centres. Occupational physicians from these centres further investigate the work-relatedness and report the cases.

In systems aimed at specific groups of WRDs, the main reporters are various groups of specialists: for example, pulmonologists in systems for respiratory diseases (SWORD, ONAP2, SABRE, SORDSA, OWRAS); dermatologists in cases of skin diseases (EPIDERM); or infectiologists in SIDAW. Employers and employees can report in some systems reporting work-related injuries and diseases (RIDDOR and iReport); however, an accompanying medical diagnosis is required.

Most of the systems rely on the voluntary participation of reporting physicians. However, reporting is obligatory in six systems: MALPROF (Italy), the Norwegian and Dutch registries, and in both the systems reporting work-related injuries and diseases — RIDDOR (UK) and iReport (Singapore). In the French RNV3P system, reporting is obligatory in cases of established occupational or work-related diseases, whereas the reporting of suspected new/emerging WRDs is based on the voluntary participation of reporting physicians.

The majority of systems use online forms for reporting cases, although MALPROF and RNV3P still rely on communication via paper forms. All systems meant for work-related respiratory diseases (SABRE, SORDSA, OWRAS) use the same reporting forms as those in the UK SWORD programme. Singapore's iReport's innovative online one-step platform for the reporting of work-related injuries and diseases enables easy submission via this user-friendly platform and also allows SMS and email acknowledgement. Since iReport was launched, the proportion of submissions received via electronic means increased from about 50 % in 2006 to more than 90 % in 2009, confirming increased engagement among the users and the enhanced usability of the system.

While most of the systems rely on physicians spontaneously reporting during their usual clinical practice, in some systems, reporting occurs at specific time intervals. This is characteristic of the programmes aimed at specific groups of diseases. Thus, in the THOR schemes — SWORD, EPIDERM, and OPRA — a chosen 'core' group of physicians report monthly, whereas the remaining randomly assigned specialists ('sample' reporters) report during one month per year. However, all reporting physicians can report cases identified outside their reporting month to the THOR-EXTRA scheme, if they feel the case is specifically significant from the perspective of new/emerging risks. In SIDAW and OWRAS, reporting occurs monthly. In the Surveillance Programme in Occupational Health in Navarre, reporting occurs weekly.

The collected data are similar in all the systems that are based on physician reporting. The programmes for respiratory diseases (SABRE, SORDSA, OWRAS) require additional information, on matters such as the presence of specific symptoms, smoking status, etc. All THOR schemes collect a common set of data; however, reporters receive detailed reporting guidelines specifically adapted for each of the schemes. When assessing the exposure, most of the systems rely on the information described by the reporting physician. In the case of MALPROF, information on exposure and the nature of the activity and economic sector is obtained indirectly from the work history, and is limited to the duration of the period in which the worker is supposed to have been exposed to the hazard.

### *5.2.2 Data mining in RNV3P and OCCAM*

In the French RNV3P system, data mining is used to complement the spontaneous reporting of physicians, whereas, in the Italian OCCAM system, it is the main source of data collection.

RNV3P is an example of successful data mining in the French database that contains all reports of ODs. Data mining is based on detecting new associations as in pharmacovigilance, using sophisticated statistical methods. Proportional reporting ratios (PRR), used in pharmacovigilance, are applied to detect the disproportional reporting of disease–exposure associations, which are not compensated by the national social security system. This procedure may be seen as the first step of hypothesis generation before launching epidemiological and/or experimental studies (Bonneterre et al., 2008).

In OCCAM, information regarding 'lost cases' of occupational cancer is gathered in various ways: by linking databases on diagnoses and professions, by researching special disease registries (such as the mesothelioma registry and the paranasal sinus carcinomas registry) and by identifying clusters. An example of gathering information through identification of clusters is a study of mesotheliomas in Sicily, which revealed the causal role of fluoradenite, a mineral similar to asbestos. Various other case-control studies were performed using the 'cases' identified through the Italian Cancer Registries or regional hospital discharge records and 'controls' retrieved through electronic population files. Upon the identification of 'cases' and 'controls', statistical analyses are performed to calculate a relative risk (RR) for a specific type of cancer relative to the gender and economic sector. By using data from the cancer registries, many known occupational cancer risks were associated with specific industrial sectors (new disease-exposure associations). By using cases from hospital discharge records, many at-risk industries as well as cases of recent diagnoses likely to be of occupational origin were identified. However, for some industrial sectors (e.g. the chemical industry) the approach was unable to detect any excess risk. A general limitation of this approach is that it uses information collected for administrative purposes as an indicator of occupational exposure. Such information is extremely limited in its ability to pinpoint exposure to specific hazards. For example, in the chemical industry, certain cancer hazards are linked to the production of specific chemicals (e.g. vinyl chloride) or types of chemicals, but information on the actual chemicals produced by individual companies are not available from the archives. The consequent dilution of risk is almost certainly the main reason for finding no increase in the incidence of new cases of cancer within certain industries known from other studies to be associated with increased cancer

prevalence. An additional limitation is that, in Italy, industrial sector information is archived only for private sector employees, and information on employees in important areas such as agriculture, the self-employed and the public sector is not available from the Social Security archives. Nevertheless, this approach appears to be a promising low-cost method for occupational cancer surveillance, at least for some industries, and can be easily implemented in other countries (Crosignani et al., 2006).

### 5.2.3 Monitoring health risks of nanotechnologies in EpiNano

The French EpiNano programme collects and analyses data in several steps. An exposure registry was developed to keep records of companies and workers producing or handling nanomaterials. Detailed qualitative exposure assessments have since been carried out, and those who agreed to be followed up were included in a prospective study, which is restricted to monitoring the health effects of a few nanomaterials of interest. Data are collected through medical documentation issued by insurance organisations, hospitals, occupational health physicians (obtained through regular medical examinations of workers) and via worker questionnaires. At this stage, exposure is also quantitatively assessed. Repeated cross-sectional studies will be performed with the objective of documenting the circumstances of exposure to all types of nanomaterials and to create hypotheses on possible health effects (Boutou-Kempf et al., 2011). In this programme, 23 companies were recruited and visited, and 156 eligible workers have been identified and included in the programme for epidemiological follow-up, based on the national health security medico-administrative database (Programme médicalisé du système d'information (PMSI), a primary source of data for the surveillance of prevalent and incident morbidity) (L'Agence régionale de santé, 1996).

## 5.3 Evaluation of work-relatedness and use of data

Table 13 presents information on those involved in the evaluation of work-relatedness, the mechanism used to provide feedback to reporters on the final decision of a case's work-relatedness, the follow-up of suspected cases of new/emerging WRD, and on the dissemination of results and links with prevention. Finally, the table provides information on the collection of reported cases for a database and the availability of the database for public research.

**Table 13: Evaluation of work-relatedness and use of data in non-compensation-related systems primarily designed for data collection and statistics**

| Type | Country (system) | Evaluation of work-relatedness | Feedback to reporter | Follow-up of new/emerging risk | Dissemination of results | Link with prevention | Collection into a database |
|---|---|---|---|---|---|---|---|
| 2A/2B/2A+ | United Kingdom and Ireland (6 THOR schemes: THOR-GP; OPRA; SWORD; EPIDERM; SIDAW; THOR-EXTRA) | COEH, University of Manchester | Indirectly (summaries from all THOR schemes are produced every three months and circulated to reporting physicians) | Yes, national and international expert group | International papers/symposia, website | Workplace inspection by labour inspection | Yes (public) |
| 2A | Italy (MALPROF) | Occupational physician of ASL | No | Yes, national expert group | MALPROF report every two years, website to disseminate information an research results | No specific link with prevention | Yes |
| 2A | Norway (RAS) | Medical doctors in the labour inspectorate authority | Yes | Yes | International papers/symposia/newsletters/reports | Workplace inspections; national-level data may also be used in planning prevention activities | Yes (public) |

| Type | Country (system) | Evaluation of work-relatedness | Feedback to reporter | Follow-up of new/emerging risk | Dissemination of results | Link with prevention | Collection into a database |
|---|---|---|---|---|---|---|---|
| 2A | France (MCP) | A group of experts composed of epidemiologists from InVS, an occupational physician and a regional medical officer inspector of labour | Yes | Yes, national expert group | International papers, reports, dissemination through website | No specific link with prevention | Yes |
| 2A | The Netherlands (NODR and PIM) | Reporting occupational physician; occupational disease specialist of NCOD checks all reports and can contact reporters for more information | No record | No | Annual report | National-level data may be used in planning prevention activities | Yes |
| 2A | Spain — Navarre | Occupational physicians from INSL | Yes | Yes | Periodical newsletters to summarise information for specific period, annual visits to INSL to discuss cases | No record | Yes (public) |
| 2A+ | France (RNV3P) | ANSES experts in dedicated working group on emerging | Always, and sometimes reporter is involved in | Yes, national expert group | French prevention agents in working group; several levels of dissemination: (1) internal alert to clinicians in RNV3P network, (2) | Diffusion via ANSES to authorities for necessary | Yes |

| Type | Country (system) | Evaluation of work-relatedness | Feedback to reporter | Follow-up of new/emerging risk | Dissemination of results | Link with prevention | Collection into a database |
|---|---|---|---|---|---|---|---|
| | | work-related diseases | experts' group discussions | | information to RNV3P partners, search for similar cases outside network, (3) widely diffused via ANSES to authorities for necessary actions, and (4) international papers/symposia, reports | preventive actions | |
| 2B | France (EpiNano) | Not formed yet | Yes but based on pulled data, not on individual company level | Yes; cohort studies, follow-up worker questionnaires, collaborative panel and cross-sectional studies | Annual short report to companies and workers, and to French ministries of Health and Labour, scientific abstracts and articles; dissemination through journals of involved professional societies; quarterly newsletters; brochures on hazardous respiratory agents in the workplace | Transfer of computerised onsite data, readily available for implementing control banding approach; identifications of workstations with high exposure potential | Yes |
| 2B | South Africa (SORDSA) | Reporting physician | Indirectly | No | Dissemination through journals of involved professional societies; quarterly newsletters; brochures on hazardous respiratory agents in the workplace | No record | No record |

| Type | Country (system) | Evaluation of work-relatedness | Feedback to reporter | Follow-up of new/emerging risk | Dissemination of results | Link with prevention | Collection into a database |
|---|---|---|---|---|---|---|---|
| 2B | Australia (SABRE) | Reporting physician | No | No (although initially intended) | Presentation at scientific meetings and publications | No specific link with prevention | Yes |
| 2B | Canada — Ontario (OWRAS) | Reporting physician | Yes | No | No record | No record | No record |
| 2B | France (ONAP2) | Four experts review reported cases (excluding cases of work-aggravated asthma) and probability of occupational asthma classified into three categories: typical asthma, asthma-like syndrome and reactive airways dysfunction syndrome | Yes | Yes, national expert group | InVS reports | No specific link with prevention | Yes |
| 2B | Italy (OCCAM) | No record | Not applicable | Follow-up studies | Publications | Identification of high-risk economic sectors | Yes |

| Type | Country (system) | Evaluation of work-relatedness | Feedback to reporter | Follow-up of new/emerging risk | Dissemination of results | Link with prevention | Collection into a database |
|---|---|---|---|---|---|---|---|
| 2C | United Kingdom (RIDDOR) | No record | No record | No record | No record | No record | Yes |
| 2C | Singapore (iReport) | Medical doctors in occupational health clinics | No record | No record | No record | No record | No record |

The evaluation of work-relatedness differs among the systems. Some rely on the decision made by the reporting physician with no further investigation. This is the case in the Netherlands Registry and three systems monitoring respiratory diseases: SORDSA (South Africa), SABRE (Australia) and OWRAS (Canada — Ontario). In other systems, the final decision on work-relatedness is made by the acknowledged authority in a research centre (UK — THOR) or Labour Inspectorate (Norway — RAS), medical doctors in Occupational Health Clinics (Singapore — iReport) or a specific group of experts on new/emerging WRDs (France — RNV3P and InVS systems).

In some cases, reporters receive feedback on the work-relatedness decision (e.g. RNV3P, RAS, InVS systems), whereas in others no feedback is provided (e.g. MALPROF). In some systems, reporters can be informed of further analyses of the cases through summaries/reports that present the cases.

Possible new/emerging risks are not followed up in systems in which the final decision on work-relatedness is made by the reporting physician (Netherlands Registry, SORDSA, SARBRE, OWRAS),. Other systems, such as THOR, MALPROF, RNV3P, InVS, RAS and the one in Navarre, provide follow-up of the suspected cases by either a national or international group of experts. In OCCAM and EpiNano, a follow-up of cases is a core part of surveillance, and takes place through case-control and cohort studies, as previously described. Interestingly, most of the systems that do not focus on the follow-up of new/emerging WRDs are outside the EU (SORDSA, SABRE and OWRAS) whereas following up new/emerging WRDs seems to be common practice in the EU non-compensation-related systems primarily designed for data collection and statistics. This implies that the problem of new/emerging WRD is addressed in the EU countries, possibly driven by the EU frameworks and aimed specifically at dealing with this issue.

Unlike compensation-based systems, the majority of systems in this group collect and record data on identified cases of new/emerging risks into a database. In the French RNV3P system, the corresponding database has multiple functions. All cases of WRDs reported by occupational physicians are recorded in a web-based information system, with coded variables. This coding enables periodic systematic data mining. The database currently comprises about 200 000 work-related health problems (including ODs and WRDs as well as medical surveillance after exposure to carcinogenic compounds, etc.). Furthermore, the RNV3P database is used for researching new/emerging WRDs, and other researchers are allowed to access this database under certain conditions. Similarly, several other databases are used for research purposes and are available to external researchers: Norwegian RAS, UK THOR and a regional database provided by the Navarre Occupational Health Surveillance Program. The Dutch national notification and registration system can be used for research on work-related health effects, but only by internal experts. In the case of the Italian MALPROF system, all the reported cases are included in the database, which collects data regarding diagnosis — coded using the *International Classification of Diseases, Ninth Revision* (ICD-9) (Medicode, 1996) — activity sectors, job titles, type of reporting physician, experts' opinions on the causal relationship between disease and occupation, and demographic information on the worker.

The usual way of disseminating results is through international papers/symposia (e.g. THOR, RAS, OCCAM) or periodical newsletters/reports (e.g. MALPROF, Navarre). The French RNV3P system has several levels of alert: (1) internal alert to clinicians in the RNV3P network; (2) information is passes to RNV3P partners and searches are conducted for similar cases outside the network; and (3) wide diffusion via ANSES to authorities to take necessary actions. This is a good example of dissemination and the exchange of information at a national level that can be used to initiate preventive actions.

# 6 Sentinel systems

Monitoring systems in the sentinel group are specifically designed to provide a signal that will initiate health interventions and preventive actions. Of the 12 identified sentinel surveillance systems, six are aimed at all work-related or occupational diseases (coded 3A), of which four are additionally intended to identify new/emerging work-related health problems (coded 3A+). Six other systems focus on one or a subset of work-related or occupational diseases (coded 3B). Eleven sentinel systems are described in this section (one system was excluded as described in Section 4.2).

The systems identified in this group are implemented in only a few EU countries (Belgium, the Netherlands and Modernet countries) and in the USA and New Zealand. They are mostly maintained by specialised research organisations (occupational and environmental health institutes, institutes for public health surveillance, or departments of labour). An international system (Signalling new occupational disorders (SIGNAAL)) was also identified in this group, initiated by occupational health physicians and experts in the Netherlands and Belgium. Another system designed with an international scope is the Occupational Diseases Sentinel Clinical Watch System (OccWatch), created by specialists from Modernet. However, this system is coordinated by the French ANSES and most of the reported cases are from France even though Modernet experts from other countries can also report. In addition, both SIGNAAL and OccWatch have a somewhat international approach to work-relatedness evaluation, allowing experts from different countries to discuss cases and participate in the work-relatedness decision. All other systems from this group are nationwide (the Sentinel Event Notification System for Occupational Risks (SENSOR) is a nationwide concept that is implemented on a state level across the USA) and, according to the information available, cover all economic sectors. The systems cover both genders, and SMEs. In terms of disease coverage, most of the systems have a broad scope and aim to monitor all WRDs and ODs. Even though initially designed to monitor a wide range of WRDs, the USA SENSOR programme was eventually reduced to the Pesticide Monitoring Scheme, which remains the only active programme derived from SENSOR. Moreover, the New Zealand system (NODS) had several specialist panels for specific WRDs (Cancer Panel, Chemical Panel, Respiratory Diseases Panel and the Solvent Panel), but only one of these remains active (Respiratory Diseases Panel).

The reporting of cases is based on the voluntary participation of reporters, mainly occupational physicians. In some systems, other professionals, such as occupational health nurses, general practitioners, etc., may also report. In two systems, employers or workers can report a work-related health complaint, whereas one system (USA — Health Hazard Evaluation (HHE) system) is completely based on workers' notifications of health complaints. As regards data collection, these systems are characterised by more detailed exposure assessment (compared to those of other groups), which includes a more thorough description while reporting and possible workplace inspection with data gathering. In the specialist panels of New Zealand, NODS, additional data are collected by reviewing cases notified by the registries, such as the Cancer Register, Asbestos Disease Register, Asbestos Exposure Register, etc. Moreover, work-relatedness is evaluated with a high level of expertise, by a team of experts on new/emerging WRDs in some of the systems. In the two international systems

(SIGNAAL and OccWatch), evaluation is performed by specialists from different countries. Suspected cases of new/emerging WRDs are followed up in all identified sentinel systems. In addition to the common means of disseminating data, such as case reports, international conferences, websites, etc., these systems have a strong link with workplace prevention, which is one of the main strengths of these systems. Preventive actions include a wide range of activities, such as direct workplace interventions aimed at co-workers or workplace causes; different forms of primary prevention (guidance regarding exposure or health surveillance, exposure reduction or substitution) and secondary prevention (finding occupational cause of a cluster). In all the systems, the cases are collected in a database, which is seldom available to the public. In the cases of the SIGNAAL and OccWatch systems, the online databases provide a platform for discussion between experts, including identification of similar cases.

Table 14 presents the main characteristics of these systems, including the name, country, institution maintaining the system, type of WRD reported, and coverage of the systems (economic sectors, including information on SMEs inclusion). In the case of the USA SENSOR programme, an issue was whether the information retrieved was still up-to-date. Indeed, references in which a general description of this system is provided date back as far as the late 1980s, when SENSOR was first designed (Baker, 1989). The articles and reports published in the following years mainly referred to specific branches of this system implemented in various states across the USA. Finally, the SENSOR Pesticides Program, which is the only remaining active SENSOR monitoring scheme, was most recently described in an article published in 2016 (Fortenberry et al., 2016). Thus, SENSOR is present in the table in two forms: one is the initial concept, as described in the 1980s, and the other is the currently active SENSOR Pesticides Program. Unfortunately, we did not receive the authors' feedback on the information we gathered regarding SENSOR, so the data presented are limited to those retrieved from the available literature.

**Table 14: Main characteristics of sentinel systems**

| Type | Country (start date) | System | Organisation maintaining the system | Type of WR/ OD reported | Sectors/workers covered |
|---|---|---|---|---|---|
| 3A | USA (1987) | Sentinel Event Notification System for Occupational Risks (SENSOR) | National Institute for Occupational Safety and Health (NIOSH), Centers for Disease Control and Prevention (CDC) | Silicosis, occupational asthma, pesticide poisoning, lead poisoning, carpal tunnel syndrome, noise-induced hearing loss, or other conditions depending on the state | 10 states |
| 3A | USA (1971) | NIOSH Health Hazard Evaluation (HHE) Program | National Institute for Occupational Safety and Health (NIOSH) | Any type of workplace risk | Working population of the USA and US territories |
| 3A+ | Belgium and the Netherlands (2013) | SIGNAAL | Netherlands Center for Occupational Diseases and Center of Environment<br>University of Leuven, Center for Environment and Health | All | All sectors, SMEs included |
| 3A+ | France* (2013) | OccWatch: Occupational Diseases Sentinel Clinical Watch System project | Modernet (Monitoring Occupational Diseases and Emerging Risks New Network) | All | No record |
| 3A+ | France (2008) | GAST: Occupational Health Warning Groups | French Institute for Public Health Surveillance (InVS) | Unusual health events at workplace | All sectors; SMEs included |

| Type | Country (start date) | System | Organisation maintaining the system | Type of WR/ OD reported | Sectors/workers covered |
|---|---|---|---|---|---|
| 3A+ | New Zealand (1992) | Notifiable Occupational Disease System (NODS) | WorkSafe New Zealand | ODs that fall under the legislative definition of 'serious harm' | Working population of New Zealand; SMEs included |
| 3B | New Zealand | Cancer Panel (NODS) | Department of Labour (DoL) | Occupational cancer | Working population of New Zealand; SMEs included |
| 3B | New Zealand (2001) | Respiratory Diseases Panel (NODS) | WorkSafe New Zealand | Occupational respiratory diseases | Working population of New Zealand; SMEs included |
| 3B | New Zealand | Solvent Panel (NODS) | Department of Labour (DoL) | ODs related to organic solvents | Working population of New Zealand |
| 3B | New Zealand | Chemical Panel (NODS) | Department of Labour (DoL) | ODs related to chemical toxicity | Working population of New Zealand; SMEs included |
| 3B | USA | SENSOR Pesticides Program | NIOSH; California Department Of Pesticide Regulation (CDPR); US Environmental Protection agency (EPA); Office of Pesticides Programs (OPP); American Association of Poison Control Centers (AAPCC) | Acute occupational pesticide-related illness and injury | 11 states |

*OccWatch is a system developed within the Modernet network coordinated in France.

### 6.1.1 Development of sentinel surveillance in occupational health with SENSOR

The USA's SENSOR programme was the first example of a sentinel surveillance system in occupational health. In the 1980s, the idea of a sentinel health event notification in occupational health was described by Rutstein (Rutstein et al., 1983), which he defined as a disease, disability, or untimely death which is occupationally related, and the occurrence of which may:

- provide the impetus for epidemiologic or industrial hygiene studies; or
- serve as a warning signal that materials substitution, engineering control, personal protection, or medical care may be required.

This idea eventually led to the launch of SENSOR (Baker, 1989), maintained by the National Institute for Occupational Safety and Health (NIOSH) and the federal Centers for Disease Control and Prevention (CDC). The system was designed to provide WRD monitoring and reporting (including case finding), manage the reported cases (including case confirmation), screen possible diseases in co-workers of the case, evaluate the worksite factors potentially responsible for the case, issue workplace-specific recommendations for hazard abatement, and to develop and maintain preventive activities. Thus, the primary aims of SENSOR were prevention and workplace interventions, with a possibility of detecting new/emerging occupational health risks. The concept consisted of two organisational components: a network of sentinel providers (e.g. individual practitioners, laboratories and/or clinics) identified in each state system; and a surveillance centre, in charge of data analyses, whose intervention activities were directed at individual cases, co-workers and worksites. NIOSH developed a list of conditions to be reported, and reporting criteria. This included carpal tunnel syndrome, lead poisoning/elevated blood lead levels in adults, noise-induced hearing loss, occupational asthma, pesticide poisoning and silicosis. Depending on the evaluation of occupational risks, which may vary from state to state, the surveillance centres could propose other conditions to be reported. This concept of SENSOR was meant to be implemented in 10 states across the USA. However, different SENSOR programmes aimed at monitoring specific WRDs (mentioned above) gradually stopped collecting data. The SENSOR Pesticides Program (Fortenberry et al., 2016) remains the only currently active surveillance system derived from the initial SENSOR concept. This system still collects data on acute occupational pesticide-related illness and injuries from 11 states across the USA.

### 6.1.2 Health Hazard Evaluation Program — assessment of workplace risks

In 1971, the USA's NIOSH introduced a programme for identifying chemical, biological or physical risks at the workplace: the HHE Program. Multidisciplinary teams stationed at five different locations in the USA carry out this research upon the request of employers, employees or employee representatives, and other public-sector agencies. In the case of employee requests, an application submitted by at least three employees is sufficient for a HHE, provided that initial discussions confirm the existence of a

serious health problem that is likely to be work related. The teams comprise physicians with various backgrounds, occupational health specialists, epidemiologists, technicians, psychologists and statisticians. When a request is received, the programme staff members decide on an appropriate response and, depending on the nature of the problem, assign the relevant experts. It has emerged that the engagement of the teams is mainly useful for the evaluation of new problems, such as cases in which the cause of disease is unknown, or exposure to substances or processes for which no regulations exist (Van der Laan et al., 2009).

### 6.1.3 International pilot projects — SIGNAAL and OccWatch

The SIGNAAL project (Lenderink et al., 2015) was initiated in 2013 as a collaboration between the Netherlands Center for Occupational Diseases and the Center of Environment and Health of KU Leuven (Belgium). It is an online tool specifically designed for reporting and assessment of new work-related health risks by occupational health physicians and experts in the Netherlands and Belgium.

If registered to access the system, any (occupational) physician can report a case involving one or more workers. Occupational physicians are informed of the possibility of participating in the SIGNAAL programme through scientific publications, especially in the Dutch Journal for Occupational and Insurance Medicine (Het Tijdschrift voor Bedrijfs- en Verzekeringsgeneeskunde, TBV) as well as through various conferences held across Belgium and the Netherlands. As the SIGNAAL project is still in its pilot phase, dissemination has mainly been performed in Belgium and the Netherlands so far. However, further internationalisation of the project is foreseen in the future. The reporting physician has to provide details on the worker(s), the health problem, the work tasks, the specific exposure and considerations as to why this issue might be a work-related illness. Occupational health specialists assess the reports in a structured way to assess whether the case could be a work-related illness and whether it is a new occupational health problem. A literature search is performed to find scientific evidence. After this assessment, the reporter is informed of the results. Follow-up research may follow, to underpin the case, and it may be reported to the relevant stakeholders (see example described in Section 7.3).

OccWatch (Palmen, 2016; Bonneterre, 2013) was designed by the Modernet network of international experts on new/emerging work-related risks. The project was initiated in 2013, and is currently in its pilot phase. The main objectives of this system are to:

1. Capture case reports of potential new WRDs;
2. Exchange and analyse the relevance of clinical signals through challenging diagnoses, exposure, work-relatedness, physiopathology and prevention issues and hypotheses on causative agents, and through seeking similar cases;
3. Summarise, producing common expertise within two months of the case being posted (if possible) and reaching a conclusion regarding medical data, but also including first information on risk assessment (population potentially exposed, severity), and proposals for actions to be taken if necessary;
4. Disseminate the briefing note to institutions concerned, if possible, including national agencies, etc., bearing in mind that these institutions may or may not decide to alert or take specific actions.

### 6.1.4 GAST: Occupational Health Warning Group

Another French surveillance system was initiated in 2008 to provide an epidemiological response to unusual health events at workplaces and to identify new/emerging work-related health risks and diseases. The system is called Groupe d'alerte en santé travail (GAST): Occupational Health Warning Group, and is maintained by the InVS and the other French systems described in the current review. This system enables the reporting of any type of unusual health events at workplaces (e.g. clusters of cancers or other diseases, non-typical exposures), and covers all economic sectors in France. When the regional platform for monitoring and health emergencies (Agence Régionale de Santé, ARS) receives a signal from the health field, validation and evaluation are carried out. If this signal seems unusual (grouped cases of cancer, poisoning, industrial accidents, etc.), it is directed to the Regional Epidemiological Units (Cellules de l'InVS en Région, CIREs), which mobilise the GAST group of experts. These experts then have a period of one month to confirm the signal, raise an alert, initiate an investigation if necessary and make a decision, if appropriate, regarding any consequent prevention measures to be implemented.

### 6.1.5 Disease-specific monitoring with specialist panels in NODS

NODS (To, 2015) (Health Outcomes International PTY LTD et al., 2005) was established in New Zealand in 1992 to enable the notification of health-related conditions that are suspected to have arisen from work. NODS was initially administered by the Occupational Safety and Health Service (OSH) of the Department of Labour (DoL). However, in 2005, WorkSafe New Zealand took over the maintenance of the system. NODS covers the entire working population of New Zealand. It was created with the objective of enabling the OSH Service (NZ-OSH) to become aware of work-related health problems (in effect, identifying a 'sick workplace' on the basis of 'sick workers') and to pursue improvements, implement adequate preventive strategies and provide a database for the development of applied research. Notifiable cases are ODs that fall under the legislative definition of 'serious harm'.

The NODS process involves the following four stages:

1. notification of a possible work-related condition;
2. assessment and/or investigation of the individual worker, their work and their workplace by the health and safety team of the local OSH branch;
3. verification of the reporting by departmental medical practitioners, who can request further assistance from specialist medical panels;
4. entry of confirmed cases into the OSH database.

Initially, NZ-OSH had several specialist panels for reviewing notifications. These panels comprised medical and non-medical specialists, and included NZ-OSH and non-NZ-OSH members. The panels were the Cancer, Chemical and Respiratory Diseases Panels (the former Asthma and Asbestos Panels) and the Solvent Panel. However, of these, only the Respiratory Diseases Panel is still active; the other three no longer collect data. The NODS system is currently under review to determine its future.

## 6.2 Reporting mechanism and data collection

Table 15 presents information regarding the reporting mechanism, such as type of reporter or whether the system is based on the voluntary or obligatory participation of the reporters, and data collected by the system, including exposure assessment.

**Table 15: Reporting and data collection in sentinel systems**

| Type | Country (system) | Type of reporter | Reporting mechanism | Data collected | Information on exposure |
|---|---|---|---|---|---|
| 3A | USA (SENSOR) | Physicians | Depends on state, telephone/email | Detailed work and medical histories, including work-relatedness information | No record |
| 3A | USA (HHE) | Employers, employees or employee representatives, and other public-sector agencies | Voluntary (request-driven system), on paper/telephone/ online (website) | Active workplace evaluations carried out by multidisciplinary teams | Assessed via workplace inspections carried out by multidisciplinary teams |
| 3A+ | Belgium and the Netherlands (SIGNAAL) | Occupational physicians, respiratory physicians and general practitioners | Voluntary, online form (website) | Worker's age, gender, description of health complaints, diagnoses, diagnostic testing, job description, industrial sector, exposure, protective measures and equipment, work-relatedness | Described by reporter; additional assessment occasionally in follow-up research |
| 3A+ | France* (OccWatch) | Occupational physician/specialists from Modernet | Voluntary, web-based platform | Patient's demographic characteristics, principal disease and comorbid diseases, principal exposure and other possible exposures, occupational title and sector of professional activity; it is also possible to attach additional informative documents about the case | Described by reporter |

| Type | Country (system) | Type of reporter | Reporting mechanism | Data collected | Information on exposure |
|---|---|---|---|---|---|
| 3A+ | France (GAST) | Occupational physicians (80%), Health and Safety Committee, workers, unions, managers, medical specialists, general practitioners, industrial hygienists, etc. | Voluntary | Diagnosis or symptoms, number of cases, occupational exposure of cases, demographic information in enterprise/public institution | In accordance with the phase of the investigation, exposure is described increasingly more precisely |
| 3A+ | New Zealand (NODS) | Physicians, occupational health nurses, employees, employers | Voluntary, on paper (notification card) | Name, age, gender of patient, details on the occupational disease, exposure, industry, work-relatedness, employer | Described by reporter (except cases referred to specialist panels) |
| 3B | New Zealand (Cancer Panel) | Review all cases of selected cancer sites reported to New Zealand Cancer Registry as well as cases notified to OSH | Voluntary, NODS reporting card | Demographic and diagnostic information provided by the Cancer Registry is combined with detailed occupational and exposure histories gathered through interviews of individual patients | Workplace inspections carried out if necessary |
| 3B | New Zealand (Respiratory Diseases Panel) | Review all cases reported to NODS, cases from Asbestos Disease Register, Asbestos Exposure Register | Voluntary | Information provided to OSH combined with detailed occupational and exposure histories gathered through interviews with individual patients and workplace inspection (if necessary) | Workplace inspections carried out if necessary |

| Type | Country (system) | Type of reporter | Reporting mechanism | Data collected | Information on exposure |
|---|---|---|---|---|---|
| 3B | New Zealand (Solvent Panel) | Review all reported cases related to solvent exposure | Voluntary | Information provided to OSH combined with detailed occupational and exposure histories gathered through interviews with individual patients and workplace inspection (if necessary) | Workplace inspections carried out if necessary |
| 3B | New Zealand (Chemical Panel) | Review all reported cases related to chemical exposure | Voluntary | Information provided to OSH combined with detailed occupational and exposure histories gathered through interviews with individual patients and workplace inspection (if necessary) | Workplace inspections carried out if necessary |
| 3B | USA (SENSOR-Pesticides) | Physicians | No record | Surveillance staff members collect additional information related to individual cases | No record |

*OccWatch is a system developed within the Modernet network coordinated in France.

Physicians are the primary reporters in the majority of systems, but specialists can also report in some systems, for example occupational and respiratory physicians in SIGNAAL, or industrial hygienists in OccWatch. In the HHE Program, employers, workers or workers' representatives, and other public-sector agencies can request a workplace inspection. In New Zealand's NODS, physicians, occupational health nurses, workers and employers can report suspected cases of WRDs (diagnosed by a physician). Specialists in the four expert panels (Cancer, Respiratory, Chemical and Solvent Panels) reviewed all the notified cases that were in the domain of their expertise. Furthermore, they also assessed cases notified to corresponding registries, for example the New Zealand Cancer Registry in the case of the Cancer Panel, or the Asbestos Disease Register and the Asbestos Exposure Register in the Respiratory Diseases Panel. However, as previously mentioned, the only currently active panel is the Respiratory Diseases Panel. The widest range of reporters is in the French GAST, where anyone can report an unusual health event at the workplace. In practice, about 80 % of cases are reported by occupational physicians, but cases have also been reported by health and safety committees, workers, unions, managers, medical specialists, general practitioners and industrial hygienists.

Reporting is voluntary in all systems, and most use online tools for this, except NODS, which collects data using notification cards. In SIGNAAL and OccWatch, data on suspected cases are collected via online forms filled in by the reporter. These systems also rely on exposure information described by the reporter. In SIGNAAL, an additional assessment of exposure may occasionally be made during the case follow-up. SENSOR and NODS use additional tools for actively collecting additional necessary information. In SENSOR, surveillance staff members are in charge of collecting additional information related to individual cases.

A detailed assessment of exposure, which is described increasingly more precisely according to the step of the work-relatedness investigation, is characteristic of the French GAST system.

In NODS, workplace interventions are carried out for a detailed investigation, exposure assessment and data collection. Investigating teams are multidisciplinary and may include a departmental medical practitioner, an occupational health nurse, an industrial hygienist, an accident prevention consultant and health and safety inspectors.

In the HHE Program, all necessary information is collected during the workplace evaluations, performed by a multidisciplinary team.

In conclusion, an active approach to data collection and case investigation is one of the main features of sentinel systems.

## 6.3 Evaluation of work-relatedness and use of data

Table 16 displays the information regarding the evaluation process and feedback to reporters on the work-relatedness outcome of the reported cases. It also presents the use of the data collected by the system for dissemination and preventive actions. An essential feature of the sentinel systems presented in this table is the emphasis on a wide range of preventive actions initiated by the data collected on new/emerging WRDs. Thus, we describe these features more thoroughly in the following sections and include some examples of how these preventive actions take place in practice. Finally, we show how the reported cases are collected in a database and whether this is available to public researchers.

**Table 16: Evaluation of new/emerging risks and use of data in sentinel systems**

| Type | Country (system) | Evaluation of work-relatedness | Feedback to reporter | Follow-up of new/emerging risk | Dissemination of results | Link with prevention | Collection into a database |
|---|---|---|---|---|---|---|---|
| 3A | USA (SENSOR) | Experts from state surveillance centres (staff epidemiologists, statisticians and other occupational health professionals) | Indirectly summarised case reports | Yes, national expert group | Summarised case reports; publication for public health professionals, physicians and other professionals; CDC publications | Guidelines for practitioners, actions directed towards co-workers, actions directed towards specific workplace causes | No record |
| 3A | USA (HHE) | Multidisciplinary team consisting of occupational and other specialty-trained physicians, industrial/occupational hygienists, epidemiologists, technicians, psychologists and statisticians | Written reports of evaluations are shared with employer and employee representatives and posted in the workplace | May be done by HHE Program or other groups at NIOSH | Results of HHE field evaluations are published on NIOSH website in searchable database | Recommendations provided in HHE reports | Yes (public) |
| 3A+ | Belgium and the Netherlands (SIGNAAL) | Researchers of SIGNAAL employed at the Netherlands Center of Occupational Disease and the KU Leuven | Yes | Yes, international expert group | Dissemination through international papers/symposia reports, website | Possible preventive actions | Yes |

| Type | Country (system) | Evaluation of work-relatedness | Feedback to reporter | Follow-up of new/emerging risk | Dissemination of results | Link with prevention | Collection into a database |
|---|---|---|---|---|---|---|---|
| 3A+ | France*<br><br>(OccWatch) | Modernet; international network of specialists | Yes | Yes, international expert group | Possible dissemination to institutions concerned; online case-report database | Each Modernet country is responsible for linking with prevention | Yes |
| 3A+ | France (GAST) | The regional 'Occupational Health Warning Group', comprising at least two epidemiologists from InVS, a medical WRD specialist and a regional medical officer or inspector of labour | Yes, systematic feedback (final case report) | Yes, national experts group | Systematic feedback to reporter, occupational physician, enterprise manager and health and safety committee; online publication of report | Primary prevention (guidance regarding exposure or health surveillance, exposure reduction or substitution) and secondary prevention (finding cause of cluster to be occupational) | Yes |
| 3A+ | New Zealand<br><br>(NODS) | Investigating team consisting of NZ-OSH conducts investigation, after which department medical practitioner from team makes decision; specialist panels consulted when necessary | No | Cases referred to specialist panels | Dissemination through reports | Possible preventive workplace interventions | Yes |

| Type | Country (system) | Evaluation of work-relatedness | Feedback to reporter | Follow-up of new/emerging risk | Dissemination of results | Link with prevention | Collection into a database |
|---|---|---|---|---|---|---|---|
| 3B | New Zealand (Cancer Panel) | Experts from Cancer Panel | Yes | Yes | Dissemination through case reports, studies | Workplace preventive interventions | Yes |
| 3B | New Zealand (Respiratory Diseases Panel) | Experts from Respiratory Diseases Panel | Patient, accident compensation corporation (at request of patient only) | Yes | Dissemination through case reports | Workplace preventive interventions | Yes |
| 3B | New Zealand (Solvent Panel) | Experts from Solvent Panel | No record | Yes | Dissemination through case studies presented internationally | Workplace preventive interventions | Yes |
| 3B | New Zealand (Chemical Panel) | Experts from Chemical Panel | No record | Yes | Dissemination through case studies presented internationally | Workplace preventive interventions | Yes |
| 3B | USA (SENSOR-Pesticides) | Experts' evaluation | No record | Yes, national expert group | No record | No record | Yes |

*OccWatch is a system developed within the Modernet network coordinated in France.

All systems in this group are characterised by a work-relatedness evaluation carried out by a specific group of experts. In SENSOR, the authorised specialists are experts from state surveillance centres: staff epidemiologists, statisticians and other occupational health professionals. In SIGNAAL, upon receipt, each report is reviewed by the national moderator, who decides which occupational experts should be involved in the assessment on the basis of the type of health problem presented. Each case is assessed by at least one, but preferably two or more, occupational health specialists who are experienced experts in the area or topic reported. They independently assess the reported case online to determine its work-relatedness, the novelty of the condition and the necessary follow-up required. A preliminary literature search on aetiology is performed using search strings developed for evidence-based occupational medicine and, after consensus is reached, the final decision is made by the specialists. In OccWatch, cases are evaluated and followed up by the Modernet network of specialists on new/emerging risks. The online tool OccWatch was built by Modernet to enable the discussion of cases and to strengthen the evidence of a causal relationship between exposure/work and the health effect by finding additional cases in other countries. The French InVS formed the regional 'Occupational Health Warning Group', which comprises at least two epidemiologists from InVS, a medical WRD specialist and a regional medical officer inspector of labour, who is authorised to evaluate suspected cases of new/emerging WRDs.

Two of the systems evaluate work-relatedness through workplace inspections: HHE and NODS. In the HHE Program, multidisciplinary teams carry out workplace evaluations upon receiving a request from employers, employees or employee representatives to collect data and evaluate cases. These teams consist of experts assigned by the programme staff members according to the nature of the reported problem. In NODS, in a case of suspected occupational illness or disease, NZ-OSH usually investigates the place of work. NZ-OSH uses a team approach in the investigation of ODs, and in the consequent intervention at the workplace. Investigating teams may include a departmental medical practitioner (DMP), an inspector (some with specialised health knowledge), an industrial hygienist and an accident prevention consultant. An inspector, assisted by an industrial hygienist, usually carries out the first stage of an investigation. This first stage may require the reporter to complete a standard questionnaire, monitoring of the workplace and a visit to the workplace by a specialist. Once the investigatory process has been completed (which on occasion may require input from other medical specialists), the details are referred to the DMP or to a specialist panel. The DMP considers the information gathered and makes an assessment as to whether or not the disease is a result of workplace exposure.

In all the abovementioned sentinel systems, except for NODS, reporters receive feedback on the work-relatedness outcome of the reported cases. In addition to the dissemination of the information through case reports, studies, international papers and symposia, one of the crucial characteristics of these systems is its direct link with prevention. Active response and intervention are at the heart of the SENSOR concept. Three activities may follow the confirmation of a case report. First, health officials contact the individual with an identified WRD and offer an intervention to improve health or to slow disease progression. The second action is directed towards co-workers, who are often at risk of

developing similar occupational disorders due to common workplace exposures. The screening of co-workers is often appropriate to detect early, potentially reversible, health disorders. Finally, in response to reports of individual cases, the surveillance centre can coordinate and/or carry out interventions directed at specific causes of WRD in the workplaces. In such cases, local state resources are considered and used to determine the most appropriate mechanisms for carrying out such worksite action.

Similarly, in NODS, reporting is considered an indicator of a workplace hazard. A 'sick' worker alerts NZ-OSH of a 'sick' workplace. Workplace intervention is the ultimate endpoint of the process of notification, and its objective is to prevent other workers from suffering the same consequences as a result of these work circumstances. Interventions include working with employers to achieve voluntary compliance (through the use of strategies such as engagement, education and enablement) and the use of OSH enforcement powers (e.g. written warnings, compliance orders and prosecutions).

All the sentinel systems described in Section 7 collect information on cases of suspected WRD in a database. In both SIGNAAL and OccWatch, the online databases provide a platform for discussion between experts, to identify similar cases.

A recent case study illustrates how dissemination and prevention takes place in practice under SIGNAAL. The case of a healthy male train driver was presented to the occupational health clinic. The patient complained of earaches, headaches, dizziness, unsteadiness and tinnitus. A literature search on similar cases and experts' investigation confirmed the work-relatedness of these symptoms, and the causal agent identified was sudden air pressure change. All train drivers working in east Flanders were subsequently followed up (n=502, average age 40 years, five female drivers). In the first step, drivers were questioned and checked for ear, nose and throat (ENT) problems. If ENT problems or complaints were observed, the second step was an in-depth interview. A written summary of the specificities of the problems and trips involved was requested. Of the 502 drivers followed up, 11 reported ear discomfort, and in the majority of the cases this was combined with one or more symptoms of headache, vertigo or tinnitus. As a result of these finding, a questionnaire was recommended in pre-employment examinations, and medical follow-up of train drivers, to check for obstructive Eustachian tube dysfunction or chronic otitis media, was implemented. In addition, it was emphasised that high-risk drivers (who responded positively to these questionnaires), as well as drivers experiencing these problems, should be offered a more in-depth examination, including full ENT and vestibular system examinations. Furthermore, it was recommended to alternate train-driving shifts with shifts working in the train cabin in cabins, and or the trip trajectories, which may help avoid repetitive exposure to air pressure change.

An example of how information on a suspected WRD is identified and disseminated through the OccWatch system is illustrated in a case of multiple proliferating skin lesions following long-term contact with epoxy paints. After the case was identified in France and reported on the online platform as a new disease-exposure association, it was followed by documented commentaries of 10 members from seven other Modernet countries. Eleven members from eight countries (France, the Netherlands, Italy, Finland,

Belgium, the United Kingdom, Norway and Spain) participated in the discussion. Three of the members looked at similar cases in national databases, four also asked for advice from a leading dermatologist specialised in WRD, and three also carried out bibliographic searches. After the investigation, the experts concluded that there were no similar cases reported in the French, UK or Norwegian databases, nor known by experts. However, a similar case was published in 1982 in France. This led to a discussion about this case possibly being indirectly work-related, as pseudo-epitheliomatous hyperplasia might be triggered by chronic irritation, chronic wound healing and trauma. The final conclusion was that this was not a real public concern as epoxy is widely used and there is an absence of similar cases. It was agreed that this case would be published in the scientific medical literature to be accessible to other experts facing similar cases. This is a good practical example of an international platform for discussion and exchange of information, which are essential for recognising new/emerging WRDs and initiating preventive actions.

The French GAST system provides systematic feedback on each reported case to the reporter, the occupational physician, the manager of the enterprise and the health and safety committee. In addition to the dissemination of the acquired knowledge via online publication of reports, primary prevention (guidance concerning exposure or health surveillance, exposure reduction or substitution) and secondary prevention (finding the cause of a cluster to be occupational) are mandatory actions for GAST-authorised actors.

The HHE Program has an administrative database that does not have health or exposure information. However, the database is accessible to the public and the online record of HHE reports can be searched by health or exposure topic. Practical applications of this system can be illustrated through the ‘popcorn disease’ example. In 2003, a HHE was carried out following reports of several cases of serious respiratory problems among employees in a popcorn factory. The rare lung disease (bronchiolitis obliterans) seemed to originate from exposure to a volatile flavouring: diacetyl (butter flavouring). For this reason, this occupational respiratory disorder is known as ‘popcorn disease’ or ‘popcorn lung’. After the association was confirmed, measures were taken to reduce exposure to diacetyl. A monitoring programme was set up with periodic lung function evaluations for exposed employees. Information regarding the health problems was issued to the producers and users of the flavouring. As a result, an evaluation was carried out at a diacetyl producer plant in the Netherlands, and three cases were discovered (Van Rooy et al., 2007).

# 7 Public health surveillance aimed at workers and non-workers

We identified seven surveillance systems that are aimed at both workers and the general population. This group has characteristics of public health surveillance, in the sense that it aims to monitor the health of the general population, but can also be used for work-related surveillance. Two of the systems present a module of nationwide surveys and are based on principles of active surveillance: the Self-reported Work Related Illness survey (SWI) (module of the Labour Force Survey-LFS) in the United Kingdom and the Quarterly National Household Survey (QNHS) in Ireland. These surveys are also the only two active surveillance systems identified in the whole literature review. In addition, the objective of both is to monitor all work-related or occupational diseases (coded 4A), whereas the other five aim to monitor one or a subset of work-related or occupational diseases (coded 4B). Although all seven systems are listed in Appendix B, we have chosen to present in the following sections five systems for which sufficient data are available. The majority are in EU countries (the United Kingdom, Ireland and France) but one system operates in the USA (California).

The two nationwide surveys implemented in the United Kingdom and Ireland have a similar design and the main purpose is to estimate the incidence and prevalence of WRDs. Data are collected over three-month periods, through interviews with workers (randomly selected). During these interviews, workers can report any work-related health problems.

Among the systems aimed at specific WRDs, we identified those monitoring musculoskeletal disorders, pleural mesothelioma and diseases related to pesticide exposure. Data collection in these systems is mainly based on voluntary, spontaneous reporting by medical specialists: occupational physicians, pneumologists and oncologists for mesothelioma, or surgeons and neurophysiologists in the case of musculoskeletal disorders. The US Pesticide Illness Surveillance Program (PISP) gathers additional data by reviewing the illness reports submitted to the State workers' compensation system, poison control centres (PCC) and other government agencies.

The collected data generally include information on the worker's gender, age, date and place of birth, occupational title and sector of professional activity, exposures and diagnosis. Some additional data are collected by the surveys, including work absences or factors at work that can adversely affect mental well-being or physical health.

When assessing exposure, these systems rely on the information described by the reporter. However, the US PISP requires data on the exposure of other workers and carries out additional verifications of exposure. The UK SWI and the Irish QNHS do not provide further evaluation of work-relatedness, in contrast to the disease-specific surveillance systems (4B), in which the evaluation of work-relatedness is carried out by authorised experts. All systems collect the reported information into a database. In addition, the PISP database provides the means to identify high-risk situations warranting further action to implement additional restrictions on pesticide use.

## 7.1 Main characteristics

The main characteristics of the public heath surveillance systems are presented in Table 17. Even though these systems differ in design (two are survey-based whereas the other five have a 'classic' surveillance system form), the main common feature is coverage, which includes both workers and the general population. Thus, the scope of these systems extends beyond occupational health and encroaches on public health surveillance, which is why we categorised them into the present group.

**Table 17: Main characteristics of public health surveillance systems**

| Type | Country (start date) | System | Organisation maintaining the system | Type of WRDs/ODs reported | Sectors/workers covered |
|---|---|---|---|---|---|
| 4A | United Kingdom (2001) | Self-reported Work Related Illness survey (SWI) (module of the Labour Force Survey (LFS)) | No record | All | No record |
| 4A | Ireland (1997) | Quarterly National Household Survey (QNHS) | The Central Statistics Office (CSO) | All | All adult employees occupying private dwellings (households) |
| 4B | France (1998) | The French National Program for Mesothelioma Surveillance (PNSM) | French Institute for Public Health Surveillance (InVS) | Pleural mesothelioma | All sectors |
| 4B | France (2002) | Program for surveillance of musculoskeletal disorders (TMS) | French Institute for Public Health Surveillance (InVS) | Musculoskeletal disorders | General population |
| 4B | USA — California | Pesticide Illness Surveillance Program (PISP) | California Department of Pesticide Regulation (CDPR) | Acute pesticide-related illness and injury (work-related and non-work-related) | No record |

The QNHS survey (formerly known as the Irish module of the Labour Force Survey (LFS)) is a large-scale nationwide survey carried out by the Central Statistics Office (CSO) of Ireland, covering 3,000 households weekly. It produces quarterly data on the overall number of workers and special modules in the first quarter of each year, including information on the number of workers with occupational injuries or ill-health. This enables the analysis of illness and injury rates in relation to the number of workers at a given time, and provides a sector breakdown for the data.

The equivalent of the Irish QNHS module in the United Kingdom is the SWI, collected through the UK LFS. The incidence and prevalence of occupational disease are estimated on the basis of survey data collected from 50,000 households each trimester. Questions on occupational injury and illness are asked during the winter of each year. The QNHS and SWI are the only two systems identified in the review that use active surveillance, meaning that the working population is monitored on a regular basis to retrieve information on work-related risks and diseases and to identify potential cases.

The French PNSM and TMS are schemes maintained by the French InVS and are designed to monitor specific groups of diseases, including both work-related cases and those not related to work (public health surveillance). The PNSM was established in 1998, its aim being to monitor pleural mesothelioma, and four years later (2002), TMS started collecting all cases of musculoskeletal disorders.

The PISP is a complementary scheme to the SENSOR Pesticides Program in California. PISP operates similarly to the SENSOR Pesticides Program, but the two differ in case definition and the variables used to characterise cases. PISP does not formally participate in the SENSOR Pesticides Program, but collaborates in joint activities (Calvert et al., 2010). SENSOR collects only work-related cases, while PISP collects data for both work-related and non-work-related acute pesticide-related illness/injury. An illness is considered work-related if the pesticide exposure occurs at the case's place of work. To ensure that Californian cases are counted only once, the California Department of Pesticide Regulation (CDPR) cross-references cases with those from PISP.

## 7.2 Reporting mechanism and data collection

Table 18 presents information regarding the reporting mechanism and data collection in public health surveillance systems. Two main approaches to data collection were identified: 'active', in which a random sample of the working population is interviewed to retrieve WRD cases (used by both surveys); and 'passive', in which cases of already existing work-related health problems are reported. The other three systems use this approach (as do all other systems in the review).

**Table 18: Reporting and data collection in public health surveillance systems**

| Type | Country (system) | Type of reporter | Reporting mechanism | Frequency of reporting | Data collected | Information on exposure |
|---|---|---|---|---|---|---|
| 4A | United Kingdom (SWI) | Workers | Voluntary | Three monthly | Information on disease, symptoms, exposure, occupation, economic sector, work absence | Described by reporter |
| 4A | Ireland (QNHS) | Workers | Voluntary | At the beginning the survey produced data in the first quarter of each year and from 2008, every three months | Information on disease, symptoms, exposure, occupation, economic sector, work absence, factors at work that can adversely affect mental well-being or physical health | Described by reporter |
| 4B | France (PNMS) | Occupational physicians, pathologists, pneumologists, oncologists | Voluntary | Spontaneous | Worker's gender, age, date and place of birth, occupational title and sector of professional activity, address, workplace address, exposures, duration of exposure diagnosis | Described by reporter |
| 4B | France (TMS) | Occupational physicians, surgeons, neurophysiologists | Voluntary | Spontaneous | Worker's gender, age, date and place of birth, occupational title and sector of professional activity, exposures, diagnosis | Not available |
| 4B | USA — California (PISP) | Physician and review of illness reports submitted to State workers' compensation system, PCC and other government age agencies | Obligatory, on paper/online (website) | Spontaneous | Demographic and administrative information on the patient, diagnosis, symptoms, occupation, employer, exposure (including exposure of other workers) laboratory tests | Described by reporter and additionally verified |

The QNHS collects data on work-related ill-health on the basis of the individuals' perceptions of their illness, and, if they have not had their illness certified, their perception of its relatedness to work. Individuals are asked whether they have suffered any illnesses or disabilities in the past 12 months that they believe were caused or aggravated by their work, and to describe their most recent work-related illness. In addition, questions are asked about factors at work that may adversely affect mental well-being or physical health. The aim of these additional questions is to provide information not previously available on the employees' perceptions of their mental well-being at work, and on their perception of the exposure risk in their workplace, which is significant from the perspective of new/emerging risks. In the UK SWI, data are collected in a similar way to that in the QNHS. Workers report on recent work-related illnesses by replying to specific survey questions. This reporting system has no further evaluation of work-relatedness.

Data collection in the French PNSM and TMS systems is based on voluntary, spontaneous reporting by medical specialists. Occupational physicians can report suspected cases to both schemes. In addition, surgeons and neurophysiologists may also report musculoskeletal diseases system (TMS), whereas pathologists, pneumologists and oncologists can report cases of pleural mesothelioma (PNSM). Data on work-related exposure are described by the reporting physician.

In PISP, the data are collected partially on the basis of the physician's report, whereas additional information is retrieved by reviewing medical records submitted to the state workers' compensation system, PCC and other government agencies (such as a state's Department of Agriculture). Unlike the QNHS and SWI, reporting in PISP is mandatory. Exposure data are described by the reporter and additionally verified by the county agricultural commissioner, who conducts further investigations.

## 7.3 Evaluation of work-relatedness and use of data

Table 19 displays information on work-relatedness evaluation and the use of data for dissemination and prevention in public health surveillance systems. In general, these systems are characterised by a poor link with prevention. As the two survey-based systems (SWI and QNHS) do not provide a work-relatedness evaluation, they are inadequate as the main means of monitoring new/emerging WRDs. However, they provide information on WRDs from the workers' perspective, which is a valuable complementary source of information to other monitoring schemes.

**Table 19: Evaluation of work-relatedness and use of data in public health surveillance systems**

| Type | Country (system) | Evaluation of work-relatedness | Follow-up of new/emerging risk | Dissemination of results, link with prevention | Collection into database |
|---|---|---|---|---|---|
| 4A | United Kingdom (SWI) | No evaluation (based on self-perception of reporter) | No | No record | No record |
| 4A | Ireland (QNHS) | No evaluation (based on self-perception of reporter) | No | Aggregate table given to the Health and Safety Authority and microdata generated for research purposes | Survey data collected and stored by CSO |
| 4B | France (PNMS) | InVS experts | Yes, national expert group | National and international papers/symposia, agency report | Yes |
| 4B | France (TMS) | InVS experts | No record | Website | Yes |
| 4B | USA — California (PISP) | County agricultural commissioners; commissioner's investigation reports are reviewed by PISP staff | No record | PISP database provides means to identify high-risk situations warranting CDPR action so as to implement additional Californian restrictions on pesticide use. | Yes |

The work-relatedness of the reported cases is only evaluated in the French systems and in the PISP. In the PNMS and TMS, the evaluation of work-relatedness is carried out by the 'Occupational Health Warning Group', which is composed of InVS epidemiologists, an occupational physician and a regional medical officer inspector of labour. All suspected cases of new/emerging WRDs are followed-up by the national expert group.

The PISP case definition is similar to that of SENSOR Pesticides Program, and requires information about pesticide exposure and health effects, which is then compared with the known toxicology of the pesticide exposure. Cases in SENSOR Pesticides Program and PISP that are determined to be related to pesticide exposure are categorised as definite, probable or possible. Cases are labelled definite exclusively on the basis of objective data concerning exposure and health effects, probable on the basis of a mix of objective and subjective data, and possible on the basis of subjective exposure and health effect data. All cases found by PISP are investigated by the relevant county agriculture commissioner. The CDPR provides instructions, training and technical support for conducting the investigations. These instructions include directions for when and how to collect samples of foliage, clothing or surface residues to document environmental exposures. The commissioner's investigation reports are also

reviewed by the PISP staff to identify root causes of pesticides exposure (e.g. inadequate label requirements, improper storage). Root causes are also identified using narrative descriptions and violation documentation. Cases reported by this system are collected in a database, together with those retrieved by the SENSOR Pesticides Program. The PISP database provides the means to identify high-risk situations warranting CDPR action to implement additional Californian restrictions on pesticide use. Taking illness data into consideration, CDPR may adjust the restricted entry period following pesticide application, specify buffer zones or other application conditions, or require pesticide handlers to use protective equipment that meets certain standards. Since many illness incidents result from illegal practices, illness investigations direct the attention of state and county enforcement staff to significant non-compliance activities. In some instances, changes to pesticide labels provide the most appropriate mitigation measures, and CDPR cooperates with the federal Environmental Protection Agency to develop appropriate instructions for users throughout the country. The use of liquid nitrogen for termite control gave rise to one such cooperative effort. Following the death of a Californian applicator in 1989, Californian and federal staff worked together to develop additional safety measures, which are now in force nationwide.

# 8 Conclusions and recommendations

## 8.1 Integrating different approaches to detect new/emerging WRDs

Several types of surveillance systems that can detect new/emerging WRDs are described in the literature and were included in this review. Some of these systems are designed primarily for compensation-based purposes, but still generate useful information for the detection of new/emerging WRDs (Group 1); others are monitoring systems designed primarily for data collection and statistics (Group 2); and several systems are created on the basis of the sentinel approach (Group 3). In addition, a group of systems monitor the work-related health of the general population, including workers (Group 4).

- **Strengths of the sentinel systems approach towards new/emerging WRDs**

**When it comes to detecting new/emerging WRDs, sentinel systems (Group 3) seem to have the most suitable approach.** By following the sentinel health event (SHE) model (described in Section 3.5.2), a suspected case of new/emerging WRDs reported in these systems is interpreted as an alert signal, which is strengthened if work-relatedness is confirmed by highly qualified experts. In this case, preventive actions are put in place, such as the establishment of guidelines for practitioners, actions targeted at co-workers, actions directed to specific workplace risk factors for the disease in question, etc. A direct link with prevention is one of the main strengths of these systems. Most of the sentinel systems are specifically designed for detecting new/emerging WRDs. Several good examples have been implemented in EU countries in recent years (e.g. SIGNAAL, OccWatch, GAST), demonstrating a step forward in dealing with this issue in the EU. Furthermore, recently developed international systems (SIGNAAL and OccWatch) have illustrated that the creation of a network for the exchange of knowledge and experience across borders is a promising improvement in the monitoring and prevention of new/emerging WRD. Nevertheless, systems identified in the other three groups in this report can also contribute to identifying new/emerging WRDs, despite not being designed in accordance with the sentinel approach.

- **Integrating an 'open list' approach into compensation-based systems**

**Compensation-based systems** (Group 1) **are not generally designed for detecting new/emerging WRDs but can be used to do so when they include an 'open list'** approach that allows the reporting of suspected cases of WRDs that are further investigated. For instance, the Spanish compensation-based system has two separate reporting schemes: one for already established ODs (CEPROSS) and a separate one for work-related non-traumatic health effects that may be considered ODs in the future but currently are not (PANOTRASTSS). Similarly, the Swiss and Taiwanese systems described in this report have an additional reporting scheme that is unrelated to compensation, but can initiate further compensation of identified cases, if indicated. These additional reporting schemes are mainly aimed at the prevention and identification of new WRDs, as well as compensation.

- **Evaluation of work-relatedness and link with prevention should be improved in systems designed for data collection and statistics**

**Non-compensation-related systems** primarily designed for data collection and statistics (Group 2) can **also be used for detecting new/emerging WRDs**. However, the latter is possible only **if suspected cases of new/emerging WRDs are evaluated by relevant experts** and if knowledge of these new/emerging WRDs is disseminated and linked with preventive actions. Even though many systems from Group 2 do not currently use this kind of approach towards new/emerging WRDs, there were some systems that are useful for the detection of new/emerging WRDs, such are the French RNV3P, UK THOR, Italian MALPROF, Norwegian RAS and the Spanish Surveillance System in Navarre. All of these systems carry out a thorough investigation and follow-up of individual cases of suspected new/emerging WRDs. However, **their poor link with prevention is a weak point** that provides room for further improvement of these systems.

- **Disease-specific public health surveillance systems can also provide significant information on new/emerging WRDs**

**Public health surveillance systems** that target both workers and non-workers (Group 4) have a wide scope for monitoring the health of the general population and are not generally aimed at detecting new/emerging WRDs. Nevertheless, these systems can be a valuable complementary source of information to the systems described in the other three groups. **Nationwide surveys** such as the SWI in the United Kingdom or the QNHS in Ireland **can provide a general overview of potential emerging health problems among the working population.** This kind of data could help professionals in the field of new/emerging risks in terms of **determining surveillance priorities that can be implemented in other types of surveillance systems**. **Public health surveillance systems that have a narrower scope and focus on monitoring one specific type of disease could also provide more significant, concrete work-related information.** For instance, the French systems monitoring musculoskeletal disorders and pleural mesothelioma, or the USA Pesticides Surveillance System (PISP), provide a detailed investigation of work-relatedness and follow-up for every reported case. In addition, the USA PISP is linked to the corresponding authority for pesticide regulation and can initiate restrictions on pesticides use.

## 8.2 Comprehensive data collection and coverage

- **Different approaches to data collection**

The sentinel and alert systems described in this report not only vary in terms of design, but they also draw on several different approaches to data collection. **Reporting of new cases (mainly done by physicians) was the predominant method** of data collection, but other supplementary approaches were also identified. For instance, several systems used **data mining of different information sources**. In the case of the Washington SHARP programme, this is done by reviewing data from workers' compensation databases, while in the French RNV3P programme this is done by retrieving new disease-exposure associations in a non-compensation-related database. In the case of the disease-specific monitoring system NODS in New Zealand, data mining is done by panels of specialists

in the national registry of respiratory diseases to monitor work-related respiratory diseases, and in the case of the Italian OCCAM the data mining looks at cancer registries to detect work-related cancer. The latter is also a good example of gender-sensitive data collection and analysis. **By identifying and evaluating work-related risks relative to gender and the economic sectors through data mining** in hospital discharge records and Italian Cancer Registries, this method provides **valuable data on vulnerable groups** that require specific attention. **This is a low-cost method that could be easily implemented in other countries across the EU**.

- **Coverage of specific workers' groups**

OCCAM uses a gender-sensitive approach, but **the extent to which gender-related information is used in other surveillance systems is unclear.** Although all systems cover both genders, we found no information on usage of these data by the systems. A gender-sensitive approach should be encouraged, especially in systems that have a narrow scope (e.g. are aimed at a specific type of WRD) and thus have more resources for investigating and dealing with work-related risks relative to gender. In addition, certain groups of workers, such as **the self-employed, or some specific sectors (e.g. agriculture, military and police sectors, civil servants) are poorly covered** in the systems identified in this review. Most systems excluded the self-employed. In contrast, **a large number of systems across the EU reported covering SMEs** in their surveillance scheme. This is encouraging, and this approach should also be implemented in all other systems. Therefore, the inclusion of all economic sectors, as well as SMEs, should be one of the improvement goals of sentinel and alert systems.

- **Disease coverage**

**In terms of disease coverage, we identified systems for monitoring all WRDs, and some aimed at a specific group of WRDs.** Some of the latter were designed to detect work-related respiratory diseases: the Washington SHARP Asthma Surveillance Program (Group 1), SWORD in the United Kingdom (part of the THOR scheme), SORDSA in South Africa, OWRAS in Canada, SABRE in Australia, ONAP2 in France (Group 2) and the NODS Respiratory Diseases Panel in New Zealand (Group 3). As regards other WRDs, we identified systems for monitoring the following groups: work-related skin diseases (THOR-EPIDERM in the United Kingdom and the SHARP Dermatitis Program in the USA), work-related cancer (OCCAM in Italy and the NODS Cancer Panel in New Zealand), musculoskeletal disorders (TMS in France and the SHARP Musculoskeletal Disorders Program in the USA), pleural mesothelioma (PNMS in France), work-related infectious diseases (THOR-SIDAW in the United Kingdom), WRDs related to nanomaterials exposure (EpiNano in France) and WRDs related to pesticides exposure (SENSOR Pesticides and PISP in the USA). New Zealand NODS had two additional specialist panels — the chemical and solvent panels — for monitoring WRDs related to chemical and solvents exposure.

- **Difficulties in maintaining a disease-specific monitoring system**

Interestingly, **a large number of these disease-specific systems are no longer active.** To our knowledge, this includes OWRAS (Canada), SABRE (Australia), ONAP2 (France), the SHARP Musculoskeletal Diseases Program (USA) and three out of four specialist panels in New Zealand NODS:

the cancer, chemical and solvent panels. These systems either failed to continue beyond the pilot phase or collected data for several years and then ended operations. In addition, we came across four THOR schemes that had collected disease-specific data in the United Kingdom but were no longer active: THOR-ENT (for monitoring work-related otorhinolaryngological disorders), MOSS (for work-related musculoskeletal disorders), OSSA (for work-related audiological disorders) and SOSMI (for work-related stress and mental illnesses). However, we found no specific information regarding why these systems were difficult to maintain. As most of these systems are outside the EU, perhaps the EU strategies and policies aimed at new/emerging work-related risks and diseases, and the strategies it triggers at national level encourage initiation and maintenance of these systems in the EU countries, and this may not be the case in countries outside Europe. For instance, EpiNano (for monitoring WRDs related to nanomaterials exposure) was initiated after the French Ministries of Health and of Labour were alerted to the possible impact of nanomaterials exposure on human health, and gave the InVS the task of designing the protocol for this programme and initiating its pilot phase in 2013.

- **Insufficient coverage of work-related mental health problems**

In addition to nanomaterials exposure, stress at work is also considered one of the main emerging risks and preventive goals in occupational health. However, **we could not identify any active systems specifically aimed at monitoring work-related mental illnesses.** The previously mentioned UK SOSMI (one of the THOR schemes) collected data on occupational stress and mental illness from consultant psychiatrists for 10 years. However, the system has been inactive since 2009, and data on work-related mental ill-health are now collected from occupational physicians reporting to OPRA and from general practitioners reporting to THOR-GP. **Approximately 40 % of the cases reported to OPRA and 39 % of those reported to THOR-GP are cases of work-related mental ill-health.** These data illustrate the growing significance of stress and mental illness in work-related ill-health, and that these are some of the main emerging risks. However, **the monitoring of work-related mental illnesses is still poor, and there is an obvious need for improvement**. Perhaps this could be encouraged by more specific national policies in the Member States, as in the case of nanomaterials. The development of a surveillance system aimed specifically at work-related mental ill-health, or including work-related mental illness surveillance in existing monitoring systems for new/emerging WRDs, is warranted.

## 8.3 Linking data on exposure and health effects monitoring

- **Assessing new risks through integration of exposure and health effects monitoring on different levels**

A number of emerging risks warrant particular attention at all levels, for example nanomaterials and endocrine disruptors. Little is known about exposure to these substances and the WRDs they may cause. **Integrating investigation into the exposure and surveillance of health effects may be a promising approach for assessing these new risks, as illustrated by the French EpiNano programme.** As described in the report, this surveillance system addresses work-related health problems caused by

nanomaterial exposure on several different levels. The first part of the EpiNano project focuses on exposure identification and assessment and involves developing an exposure registry of companies and workers that produce or handle nanomaterials, and a detailed qualitative exposure assessment. In the following phases, more attention will be paid to the adverse health effects caused by the exposure. These effects will be monitored through a prospective cohort study, restricted to monitoring the health effects of a few nanomaterials of interest. At this stage, further quantitative assessment of exposure will also be carried out. In addition, repeated cross-sectional studies will be performed with the objective of documenting the exposure circumstances of all types of nanomaterials and of creating hypotheses on possible health effects. In addition to gaining a better understanding of how nanomaterials affect the health of the people working with them, this will also allow the timely identification of adverse health effects as well as the implementation of proper preventive actions. As a result of the rapid increase in nanomaterial handling and use, this approach is recommended for the whole of Europe.

- **Strengthening exposure assessment in the existing monitoring systems for WRDs**

However, the initial phase of EpiNano is uniquely focused on exposure, which is not the case in the other monitoring systems identified in this review. Therefore, this specific approach to nanomaterials exposure as illustrated in EpiNano can hardly be implemented in the monitoring systems with the main focus on WRDs, rather than exposure. As discussed in Section 2, the approach to new/emerging risks and WRDs monitoring is generally based on the prevalence of the disease, the extent of exposure, the aetiological fraction of work-related diseases, etc. Regardless of these different approaches to WRDs monitoring, **exposure assessment is an important step in all types of work-related surveillance systems for detecting new/emerging risks and WRDs.** This is essential for understanding the cause-effect correlation between exposure and suspected new/emerging WRDs. Furthermore, a thorough exposure assessment provides the necessary evidence for adequate work-relatedness evaluation of new/emerging WRD cases.

The systems identified in this review had two main approaches to exposure reporting. In the first case, exposure was described by reporters (mainly physicians), who usually listed the exposure(s) they thought were linked with health complaints, and sometimes reported on the duration of the exposure. This was common practice in the non-compensation-based systems primarily designed for data collection and statistics (Group 2) and public health surveillance aimed at workers and non-workers (Group 4). On the other hand, all sentinel systems (Group 3) and some of the compensation-based systems (Group 1) provided **a more thorough additional exposure assessment**, which was taken into account when judging the work-relatedness of each reported case. For instance, in New Zealand NODS, multidisciplinary teams carried out workplace interventions for a detailed investigation, exposure assessment and data collection. Similarly, in the USA HHE Program, all the necessary information, including that on exposure, is collected through workplace evaluations performed by a multidisciplinary team. This approach is recommended to better understand the link between different kinds of exposure and their health effects as well as to improve the quality of the reporting of new/emerging WRDs.

- **'Low-threshold' approach for timely detection of new/emerging risks and WRDs**

A high level of expert involvement in the evaluation of the work-relatedness of suspected new/emerging WRDs could also foster a 'low-threshold' approach to reporting. An example of this is illustrated in the HHE Program, in which an application regarding a health complaint submitted by at least three workers is sufficient to initiate workplace inspections and preventive actions. A similar approach exists in the French RNV3P, where existence of unclear symptoms that are suspected of being work-related can be reported without a definite diagnosis. Lowering the reporting threshold, that is **allowing reporting of unclear health complaints that are potentially caused by work, increases the chances of timely detection of new/emerging work-related ill-health**. However, without an appropriate expert evaluation, this kind of reporting would lack specificity and could result in a number of 'false alarms'. Therefore, **combining the 'low-threshold' approach with adequate experts' evaluation of work-relatedness could be an efficient method for the early detection of new/emerging WRDs.**

## 8.4 Exchange of information and better link with prevention

Generally, one of the main weak points of the systems identified in the review is their **poor link with preventive actions**. Collected data are mainly disseminated through conservative means, such as case reports, international conferences and symposia, etc., whereas the collected information is hardly ever used for prevention. However, some good examples exist, mainly in the sentinel systems group (Group 3) and in some of non-compensation systems primarily designed for data collection and statistics (Group 2).

**The French RNV3P is a good example of dissemination and exchange of information at a national level that can be used to initiate preventive actions.** Upon detecting a signal, this system provides several levels of alert: (1) an internal alert to clinicians in the RNV3P network; (2) information to RNV3P partners, and a search for similar cases outside the network; (3) a wide diffusion via ANSES to authorities to take necessary actions. In addition, all cases of suspected new/emerging WRDs are collected in the corresponding web-based information system (database), with coded variables that have multiple functions. This coding enables periodic systematic data mining. Furthermore, the RNV3P database is used for research on new/emerging WRDs, and other researchers are allowed to access this database under certain circumstances.

**Several systems, such as the SHARP Asthma Program in Washington, OCCAM in Italy and EpiNano in France, use their collected data to identify high-risk economic sectors and industries.** The SHARP Asthma Program calculates a PI for different occupations and sectors, which further prioritises preventive actions and recommendations. The PI is constructed by rank ordering all industries by claims incidence rate and by incident count, and then averaging the two ranks (PI = (Incidence rank + Count rank)/2). This also allows the identification of small industries that often do not gain enough OSH attention. For instance, it led to the discovery of a high incidence of work-related asthma in the automobile collision repair industry. Later, SHARP researchers, in collaboration with the industry association, were able to determine high diisocyanate absorption from respiratory and dermal exposures.

This has led to further research on different gloves. Workers' compensation claims continued to be monitored and different control measures were implemented. Similarly, in the Italian OCCAM system, potential 'cases' of work-related cancers are identified through the Italian Cancer Registries and 'controls' are retrieved through electronic population files. Upon the identification of 'cases' and 'controls', statistical analyses are performed to calculate a RR for a specific type of cancer relative to the gender and economic sector. This way, many known occupational cancer risks were associated with specific industrial sectors (new disease-exposure associations). EpiNano uses a narrower approach, identifying companies that produce or handle nanomaterials, and follows up workers who are potentially exposed to nanomaterials. Identification of occupations and economic sectors that are at a high risk of new/emerging WRDs, as illustrated in these systems, can lead to development and implementation of targeted, timely preventive actions.

**Another example of a direct link to prevention is portrayed in the USA SENSOR system, as active response and intervention are the centre of this concept.** As previously described, three types of actions can follow the reception of a confirmed case report. First, health officials contact the individual with an identified work-related disease and offer an intervention to improve health or slow the progression of the disease. The second action is directed towards co-workers, who are often at risk of developing similar occupational disorders because of common workplace exposures. This includes both implementation of preventive actions at the workplace as well as screening of co-workers for similar health complaints. Finally, in response to reports of individual cases, the surveillance centre can coordinate and/or carry out interventions directed at specific causes in workplaces. In such cases, local authorities are considered and used to determine the most appropriate mechanisms for directing such worksite action. However, these actions were described in the 1980s, and might not correspond to the current SENSOR situation, particularly because the only remaining active scheme is the SENSOR Pesticides Program. Hopefully, the interviews with stakeholders and the in-depth exploration of SENSOR in the next stage of this project will allow us to gain more insight into the current organisation of this system.

**Two sentinel systems, SIGNAAL and OccWatch, provide an international exchange of information on several levels.** Starting with a work-relatedness evaluation, these systems gather experts on new/emerging risks from different countries (Belgium and the Netherlands in SIGNAAL and Modernet countries in OccWatch). Experts are invited to share similar cases identified in their countries and to participate in the discussion and final decision on the work-relatedness of the reported case. This information exchange takes place through an online platform, which is also used for further dissemination of the collected data. These are promising examples of international collaboration that could potentially lead to EU-wide surveillance of new/emerging WRDs.

A better link between the data collected by the systems and preventive actions can be established through:

- Dissemination and exchange of information within the national network that can further be used to initiate preventive actions.
- Identification of high-risk economic sectors and industries, with attention to SMEs and gender-inclusiveness.
- Implementation of timely workplace preventive actions, including actions aimed at co-workers and specific workplace causes.
- International collaboration and strengthening of the EU-wide network for new/emerging WRDs surveillance.

## 8.5 Role of the present review in the overall project

- **Available information on WRDs monitoring systems in the literature is limited and outdated**

The major obstacle in collecting data on monitoring systems in OSH was the **limited availability** of these data in scientific and grey literature. Moreover, an expert quality cross-check of the systems' descriptions initially drafted in the scope of this project lead to the conclusion that the information regarding WRDs monitoring systems available in both scientific and grey literature was **outdated**. For instance, some systems described in the literature stopped collecting data several years ago. In addition, some systems (e.g. GAST and OccWatch) have not yet been described in the scientific literature, thus making personal communication with the actors involved in the system the only means of retrieving information regarding these systems.

- **In-depth description of selected systems in the follow-up task**

A follow-up task of this review will seek to provide more **in-depth information on a selection of six systems**, through expert interviews and interactive discussions with and between systems developers: **SUVA (Switzerland), THOR (UK), MALPROF (Italy), RNV3P (France), SIGNAAL (Belgium and the Netherlands) and SENSOR (USA).** These were chosen as examples of monitoring systems that are good practice in one or more aspects important for the detection and prevention of new/emerging WRDs (data collection, evaluation of the data, dissemination of information, link with prevention, etc.). These six systems were chosen from different countries and from all the categories of the typology developed as part of this project. Whereas the literature review described in this report aimed to provide a general overview of the existing WRDs monitoring systems and sentinel and alert systems that can be used to detect new/emerging WRDs, the main characteristics and typology, the next steps of the project should allow us to gain more information on how these systems are actually used in practice (e.g. for the identification of risks, exposed groups, sectors and occupations, prevention, monitoring, priority setting in research), the drivers and obstacles to their implementation and maintenance, and how the data collected are used to design evidence-based prevention to formulate recommendations to improve methods for monitoring and preventing new/emerging WRDs.

# 9 Appendix A — Search protocol

The search strategy combined search terms and key terms related to the following three concepts: (1) surveillance/reporting systems; (2) occupational/work-related diseases; and (3) new/emerging risks.

The search strategy was adapted according to the different sources of research literature that were used. For instance in PubMed, key terms, namely MeSH terms (Medical Subject Headings, labelled with [MH]), were used to execute more specific searches. Every term was tested as free text using either truncation or inverted commas to select the most comprehensive search term. The use of idiosyncratic spelling was also required.

| (1) To identify potentially pertinent studies on surveillance/reporting systems, we explored the following terms: |
|---|
| Alert notification |
| Alert program |
| Alert system |
| Detecting |
| Early detection |
| Event registration |
| Health surveillance |
| Information system |
| Mandatory reporting [MH] |
| Notification program |
| Notification system |
| Occupational disease surveillance |
| Online reporting |
| Registration system |
| Report system |
| Reporting network |
| Reporting scheme |
| Reporting system |
| Sentinel event |

| |
|---|
| Sentinel health event |
| Sentinel surveillance [MH] |
| Sentinel system |
| Surveillance system |
| Tracing |
| (2) To identify potentially pertinent studies on occupational/work-related diseases, we based our search strategy on the search filters developed by Mattioli and colleagues, aiming to retrieve articles on diseases of putative occupational origin (Mattioli et al., 2010). |
| We included the following terms: |
| Occupational |
| Occupational diseases [MH] |
| Occupational exposure [MH] |
| Occupational health [MH] |
| Occupational medicine [MH] |
| Work-related |
| (3) To identify potentially pertinent studies on new or emerging risks, we explored the following terms: |
| Emerging |
| New |
| Possible |
| Potential |
| Potentially |
| Probable |
| Promising |
| Proposed |
| Putative |
| Suspected |
| Uncommon |
| Undetected |

| |
|---|
| Unexpected |
| Unreported |
| Combining and crossing them with the following terms: |
| Association |
| Hazard |
| Judgement |
| Link |
| Origin |
| Relation |
| Relationship |
| Risk |

- **Search strategy PubMed**

#1

"Alert system" OR "alert systems" OR health surveillance* OR mandatory reporting[MH] OR mandatory report* OR "surveillance system" OR "surveillance systems" OR sentinel surveillance[MH] OR "sentinel system" OR "sentinel systems" OR surveillance program* OR surveillance strateg* OR surveillance data* OR surveillance scheme* OR medical surveillance* OR sentinel event* OR sentinel health event* OR early detection* OR detecting OR tracing OR "reporting system" OR "reporting systems" OR reporting scheme* OR "reporting network" OR "notification system" OR "notification systems" OR occupational disease surveillanc* OR "online reporting" OR "report system" OR "report systems" OR alert program* OR alert notification* OR "registration system" OR "registration systems" OR event registration* OR events registration* OR notification program* OR "information system" OR "information systems"

#2

(occupational diseases[MH] OR occupational exposure[MH] OR occupational health[MH] OR occupational medicine[MH] OR work-related* OR occupational)

#3

(new OR possible OR potential OR potentially OR "probable" OR proposed OR putative OR suspected OR unexpected OR emerging OR uncommon OR unreported OR undetected OR promising) AND (association OR associations OR origin OR "origins" OR "relation" OR relations OR relationship OR relationships OR hazard OR hazards OR risk OR risks OR link OR "links" OR judgment OR judgments)

#4

#1 AND #2 AND #3

#5

#4 NOT ((animals[MH] OR plants[MH]) NOT humans[MH])

Search strategies for other databases were adopted accordingly.

**Publication Types**

- Primary research article
- Reviews
- Reports

**Inclusion Criteria**

- Studies reporting the organisation of alert systems for new/emerging WRDs
- Studies describing the results of alert systems reporting new/emerging risks

**Search Databases**

For academic research, the following databases were used to identify published articles:

- Medline (through PubMed)
- Embase
- Web of Science

Grey literature searches were carried out using the following databases:

- OSH-update (NIOSH, HSE, ILO)
- Open Grey

We also used existing data from the three following surveys:

1. European Union, Report on the current situation in relation to occupational diseases' systems in EU Member States and EFTA/EEA countries, in particular relative to Commission Recommendation 2003/670/EC concerning the European Schedule of Occupational Diseases and gathering of data on relevant related aspects. 2013;
2. Survey on monitoring systems for occupational diseases among Modernet participants (2011-2012);
3. Inventory of early warning systems existing in all European countries (clinical watch systems, databases for data mining, use of biomarkers in health surveillance etc.), currently carried out by the Dutch National Institute for Public Health and the Environment.

In addition, we reviewed the websites of the identified sentinel systems or organisations behind them:

| Organisation | Website |
|---|---|
| Allgemeine Unfallversicherungsanstalt (Austrian Workers' Compensation Board) | http://www.auva.at/ |
| Association of Workers' Compensation Boards of Canada | http://awcbc.org/?page_id=10 |
| Centers for Disease Control and Prevention (USA) | http://www.cdc.gov/niosh/topics/surveillance/ |
| Centers for Disease Control and Prevention (USA) | http://www.cdc.gov/niosh/hhe/hheprogram.html |
| Centers for Disease Control and Prevention (USA) | http://www.cdc.gov/niosh/topics/surveillance/ords/statebasedsurveillance/wra.html |
| Centers for Disease Control and Prevention (USA) | http://www.cdc.gov/niosh/topics/pesticides/overview.html |
| Central Statistics Office (Ireland) | http://www.cso.ie/en/qnhs/aboutheqnhs/whatistheqnhs/ |
| Centre for Occupational and Environmental Health (University of Manchester) | http: //www.coeh.man.ac.uk/u/opra |
| Centre for Occupational and Environmental Health (University of Manchester) | http: www.coeh.man.ac.uk/u/thorgp |
| Centre for Occupational and Environmental Health (University of Manchester) | www.coeh.man.ac.uk/u/sword |
| Centre for Occupational and Environmental Health (University of Manchester) | www.coeh.man.ac.uk/u/epiderm |
| Centre for Occupational and Environmental Health (University of Manchester) | http://www.population-health.manchester.ac.uk/epidemiology/COEH/research/thor/schemes/sidaw/ |

| Organisation | Website |
|---|---|
| Centre for Occupational and Environmental Health (University of Manchester) | www.coeh.man.ac.uk/u/ire-sword |
| Employment New Zealand | http://www.dol.govt.nz/publications/nohsac/occupational/004_content.asp |
| Työterveyslaitos (Finnish Institute of Occupational Health) | www.ttl.fi/en/press/Pages/press51_2012.aspx |
| Institut de Veille Sanitaire (French Institute for Public Health Surveillance) | http://www.invs.sante.fr/fr/Dossiersthematiques/Travail-et-sante/Maladies-a-caractere-professionnel |
| Institut de Veille Sanitaire (French Institute for Public Health Surveillance) | http://www.invs.sante.fr/fr/Dossiersthematiques/Travail-et-sante/Asthme-d-origine-professionnelle |
| Institut de Veille Sanitaire (French Institute for Public Health Surveillance) | http://www.invs.sante.fr/fr/Dossiers-thematiques/Travail-et-sante/Troubles-musculo-squelettiques-TMS |
| Institut de Veille Sanitaire (French Institute for Public Health Surveillance) | http://www.invs.sante.fr/fr/Dossiers-thematiques/Travail-et-sante/Declaration-obligatoire-des-mesotheliomes |
| Institut de Veille Sanitaire (French Institute for Public Health Surveillance) | http://www.invs.sante.fr/Dossiers-thematiques/Travail-et-sante/Epinano-Dispositif-de-surveillance-epidemiologique-des-travailleurs-potentiellement-exposes-aux-nanomateriaux |
| Fonds Voor de Beroepsziekten (Fund Occupational Diseases, Belgium) | www.fmp-fbz.fgov.be/web/index.Php |
| Deutsche Gesetzliche Unfallversicherung (German statutory accident insurance, DGUV) | www.dguv.de/de/index.jsp |

| Organisation | Website |
|---|---|
| Health and Safety Executive (UK) | www.hse.gov.uk/riddor/index.htm |
| Health and Safety Executive (UK) | www.hse.gov.uk/statistics/publications/swi.htm |
| Health Protection Surveillance Centre (Ireland) | http://www.hpsc.ie/NotifiableDiseases/NotifyingInfectiousDiseases/ |
| Országos közegészségügyi intézet (Hungarian Institute of Occupational Health) | http://www.omfi.hu/ |
| Ministry of Manpower (Singapore) | http://www.mom.gov.sg/workplace-safety-and-health/work-accident-reporting |
| L'Istituto superiore per la prevenzione e la sicurezza del lavoro (National Institute for Occupational Safety and Prevention, Italy) | www.ispesl.it/statistiche/index_mp.asp |
| National Institute for Occupational Health (South Africa) | http://www.nioh.ac.za/?page=occupational_allergies,_asthma_and_dermatitis&id=154 |
| Statens arbeidsmiljøinstitutt (National Institute of Occupational Health, Norway) | https://stami.no/ |
| Nederlands Centrum voor Beroepsziekten (Netherlands Center for Occupational Diseases) | https://ncvb.amc.nl/NCVB-MenR/dyn/user/login |
| Nederlands Centrum voor Beroepsziekten (Netherlands Center for Occupational Diseases) | http://www.occupationaldiseases.nl/ |
| L'Assurance Maladie - Risques Professionnel (Occupational Risks, France) | www.risquesprofessionnels.ameli.fr/statistiques-etanalyse/sinistralite-atmp.html |
| Ministerio de Empleo y Seguridad Social (Ministry of Employment and Social Security, Spain) | http://www.seg-social.es/Internet_1/index.htm |

| Organisation | Website |
|---|---|
| Schweizerische Unfallversicherung Fonds (Swiss Accident Insurance Fund) | www.unfallstatistik.ch/ |
| Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail (French Agency for Food, Environmental and Occupational Health and Safety) | www.anses.fr/fr?pageid=1671&parentid=943 |
| Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail (French Agency for Food, Environmental and Occupational Health and Safety) | https://occwatch.anses.fr/ |
| Státní zdravotní ústav (The National Institute of Public Health, Czech Republic) | http://www.szu.cz/publications-and-products/data-and-statistics/occupational |
| Arbeidstilsynet (The Norwegian Labour Inspection Authority) | http://www.arbeidstilsynet.no/artikkel.html?tid=79289 |
| The OCcupational CAncer Monitoring project | http://www.occam.it/en/index.php |
| UK Government | www.gov.uk/industrial-injuries-disablement-benefit |
| Washington State Department of Labor & Industries (USA) | http://www.lni.wa.gov/Safety/Research/OccHealth/Asthma/Surveillance.asp |
| Washington State Department of Labor & Industries (USA) | http://www.lni.wa.gov/Safety/Research/Projects/BRFSSWorkerHealth/default.asp |
| Worksafe New Zealand | http://www.business.govt.nz/worksafe/notifications-forms/nods |

**Screening of title, abstracts and full text**

(1) Initial screening of title and abstracts (without looking at full text) by two independent reviewers

- All abstracts will be scored:
- Score 0 = not pertinent to the research question(s)
- Score 1 = interesting paper for introduction or discussion but not answering research question(s)
- Score 2 = potentially eligible study
- Reason for excluding paper will not be documented
- No consensus needed between reviewers

(2) Screening of full-text articles

- All papers that received a score of 2 will be ordered
- A scoring sheet will be developed with inclusion and exclusion criteria and scoring YES/NO will be added
- All full texts will be scored by two independent researchers
- Consensus needed between reviewers
- A data extraction form will be developed

(3) Extraction of the selected data of the included studies by two independent reviewers

Consensus between reviewers required.

* No mental illness, 2M = two-monthly, 2M/Y = 2 months each year, 2W/6M = 2-week period every 6 months, A = active, AL = allergist, AN = annually, AS = asturias, AU = audiologist, AV = aviation, AW = raising awareness, C = continuous, CA = cancer, CAT = Catalonia, CCS = case-control studies, CP = chest physician, CS = civil servants, DC = data collection, DEF = defence forces, DEN = dentist, DER = dermatologist, DM = data mining, DM-WC = data mining from workers' compensation base, DW = domestic workers, EMP = employer, EX-M = ex-miners, EXP = expert, EXPC = expert committee, FA = farmers, FI = fishermen, FOI = forest industry, GP = general practitioner, HOS = hospitals, ID = infectious diseases, IH = industrial hygienist, ILC = identification of 'lost cases', IN = indirectly, INF = infectologist, INT = internist, LAB = laboratory, LIT = literature, M = monthly, M/Y = one month each year, MA = marine, MS = medical specialist, MSD = musculoskeletal diseases, MW = migrant workers, N = no, NA = Navarre, NER = detecting new/emerging risks, NM = symptoms and diseases related to nanomaterials exposure, NON-M = non-mining sector, NSW = New South Wales, NWR = non-work-related, OB = obligatory, OCA = occupational cancer, ODs = occupational diseases, OHN = occupational health nurse, OO = other organisations, OP = occupational physician, ORL = otorhinolaryngologist, OS = open system, P = passive, PH = physician, PL = prescribed list, PM = policy-making, PR = prevention, PS = off-shore petroleum sector, PSY = psychiatrist, PU = pulmonologist, PUB = public service employees, QUA = quarterly, REP = reporter, REV = review of cases, assessment of work-relatedness, RGs = regions, RHE = rheumatologist, RS = research, S = sometimes, SE = self-employed workers, SHI = safety and health engineer, ST = statistics, TA = Tasmania, TS = thoracic surgeon, TUD = trade union delegates, VI = Victoria, VOL = voluntary, W = weekly, WC = workers' compensation, WI = workplace inspection possible, WO = workers, WR = work-related, WRA = work-related asthma, WRAD = work-related audiological disorders, WRB = work-related bronchitis, WRCA = work-related cancer, WRDM = data mining, WRID = work-related infectious diseases, WRMD = work-related mental disorders, WRMSD = work-related musculoskeletal disorders, WROD = work-related otorhinolaryngological disorders, WRR = work-related rhinitis, WRRD = work-related respiratory disorders, WRSC = work-related skin changes, WRSD = work-related skin disorders, Y = yes.

Regional identifiers and country codes:
AT = Austria
AUS = Australia
BC = British Columbia
BE = Belgium
BU = Bulgaria
CA = Canada
CH = Switzerland
CN = China
CZ = Czech Republic
DE = Germany
DK = Denmark
ES = Spain
FR = France
FI = Finland
HU = Hungary
IE = Ireland
IT = Italy
KOR = South Korea
NL = the Netherlands
NO = Norway
NZ = New Zealand
QU = Quebec
RU = Russia
SA = South Africa
SW = Sweden
TW = Taiwan
UK = United Kingdom
USA = United States of America
WA = Washington

# 10 Appendix B — Long list of identified surveillance systems

| Type | Surveillance system | Country | Type of organisation, institution | Aim of system | Aimed only at workers | Type of ODs reported | Region, sectors covered | Prescribed list of ODs | Passive or active surveillance | Who can report? | Reporting mechanism | Frequency of reporting | Data collected by the system | Information on exposure | Evaluation committee | Evaluation and analysis | Feedback to reporter | Dissemination of results; link with prevention | Follow-up of possible new/emerging risk | Collection of data into a database | Start date | End date | Formally evaluated | Website available |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1A | Reporting of suspected ODs during mandatory worker medical examinations | RU | Rospotrebnadzor Centre of Occupational Diseases, Territorial Department of Federal Service for Oversight of Consumer Protection and Welfare | WC | Y | All | – | Y | P | OP | OB | – | – | Y | EXPC | EXP | N | – | – | – | – | – | – | – |
| 1A | Occupational Diseases Registry of the Social Security System; CEPROSS and PANOTRASTSS | ES | Insurance Fund, Inspectorate of the Social Security System (CEPROSS and PANOTRASTSS) | WC | Y | All* | All | Y | P | OP<br>PH<br>IH<br>WO | OB | – | Worker's gender, age, occupational title and sector, address, workplace address, exposure, diagnosis | Y | EXPC | EXP<br>LIT | S | Y<br>Reports | Y | N | 1989 | – | Y | Y |

| Type | Surveillance system | Country | Type of organisation, institution | Aim of system | Aimed only at workers | Type of ODs reported | Region, sectors covered | Prescribed list of ODs | Passive or active surveillance | Who can report? | Reporting mechanism | Frequency of reporting | Data collected by the system | Information on exposure | Evaluation committee | Evaluation and analysis | Feedback to reporter | Dissemination of results; link with prevention | Follow-up of possible new/emerging risk | Collection of data into a database | Start date | End date | Formally evaluated | Website available |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1A | The UK Industrial Injuries Disablement Benefit Scheme (IIDB) | UK | The Industrial Injuries Advisory Council (IIAC) | WC | Y | PL | All, no SE | Y | P | WO | V OL | – | Demographic and administrative information, diagnosis, employer, occupation, information on GP, medical treatment, previous claims | N | EXPC | LIT | – | Y Papers/symposia/ website | – | – | 1991 | N | Y | Y |
| 1A | Occupational Injury Benefit (OIB) and Disablement Benefit | IE | Department of Social and Family Affairs (DSFA) | WC | Y | PL | All, no SE, DEF, PUB | Y | P | WO | V OL | – | – | – | – | – | – | – | – | – | – | – | – | – |
| 1A | Czech Registry of Occupational Disease | CZ | Státní Zdravotní ústav (National Institute of Public Health) | ST PR RS | Y | – | All, no SE | Y, OS | P | PH | OB | – | Demographic and administrative information on the patient, diagnosis, exposure, occupation, economic sector | Y | EXPC | EXP | – | Y | – | – | 1991 | – | Y | Y |

| Type | Surveillance system | Country | Type of organisation, institution | Aim of system | Aimed only at workers | Type of ODs reported | Region, sectors covered | Prescribed list of ODs | Passive or active surveillance | Who can report? | Reporting mechanism | Frequency of reporting | Data collected by the system | Information on exposure | Evaluation committee | Evaluation and analysis | Feedback to reporter | Dissemination of results; link with prevention | Follow-up of possible new/emerging risk | Collection of data into a database | Start date | End date | Formally evaluated | Website available |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1B | Erhvervssygdoms-registret | DK | Labour inspectorate — Working Environment Authority, National Board of Industrial Injuries | – | Y | – | – | Y, OS | P | PH, DEN, WO, TUD EMP | OB | – | – | – | EXPC | – | – | – | – | Y | – | – | – | – |
| 1B | Finnish Register of Occupational Diseases (FROD) | FI | Finnish Institute of Occupational Health (FIOH) | ST, RS | Y | All | All | - | P | PH | OBL | – | Worker's gender, age, date of birth, occupational title and sector, address, workplace address, exposures, duration of exposure, diagnosis, symptoms, date of symptoms onset | Y | EXPC | EXP, LIT | N | Y | N | N | 1964 | - | Y | Y |

| Type | Surveillance system | Country | Type of organisation, institution | Aim of system | Aimed only at workers | Type of ODs reported | Region, sectors covered | Prescribed list of ODs | Passive or active surveillance | Who can report? | Reporting mechanism | Frequency of reporting | Data collected by the system | Information on exposure | Evaluation committee | Evaluation and analysis | Feedback to reporter | Dissemination of results; link with prevention | Follow-up of possible new/emerging risk | Collection of data into a database | Start date | End date | Formally evaluated | Website available |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1B | Mandatory reporting and registration system of occupational diseases | HU | Office of the Chief Medical Officer (Department of Occupational Health) OTH-MFF | WC, ST, PM | Y | All | All, no SE, DF | Y, OS | P | PH | OB | – | Gender, age, occupational title and sector, worker's address, workplace address, duration of exposure, diagnosis, level of imputability, susceptibility | Y | EXPC | EXP, LIT | Y | Y Reports, stakeholders | Y | Y | 1996 | – | N | Y |
| 1B | Statutory Health Surveillance for Occupational Diseases | CH | Insurance Fund — Swiss Accident Insurance Fund (SUVA) | PR, WC | Y | All | All, no SE, DF | Y, OS | P | PH | V OL | – | Worker's gender, age, date of birth, sector of professional activity, address, workplace address, diagnosis, specific medical information | WI | EXPC | EXP, LIT | S | Y Reports, symposia, WI | Y | N | 1984 | – | Y | N |
| 1B | Régime Général | FR | National Fund for Insurance of | WC, PR | Y | All | All, no SE, | Y, OS | P | WO | – | – | Demographic characteristics of the patient, | Y | EXP | – | – | Y | – | Y | 2002 | – | Y | Y |

| Type | Surveillance system | Country | Type of organisation, institution | Aim of system | Aimed only at workers | Type of ODs reported | Region, sectors covered | Prescribed list of ODs | Passive or active surveillance | Who can report? | Reporting mechanism | Frequency of reporting | Data collected by the system | Information on exposure | Evaluation committee | Evaluation and analysis | Feedback to reporter | Dissemination of results; link with prevention | Follow-up of possible new/emerging risk | Collection of data into a database | Start date | End date | Formally evaluated | Website available |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (General Regime) | | Occupational Diseases for Employees in the Private Sector | | | | CS, FA | | | | | | diagnosis, occupation, economic sector, exposure, duration of exposure | | | | | | | | | | | |
| 1B | DGUV Statistics | DE | German Statutory Accident Insurance (DGUV) | WC | Y | All | – | Y, OS | P | PH, WO, EMP | – | – | Demographic characteristics of the patient, diagnosis, occupation, economic sector, exposure, duration of exposure, level of imputability | Y | EXPC | – | – | – | – | – | 1975 | – | – | Y |
| 1B | Occupational disease register | BU | Insurance Fund — National Social Insurance Institute | WC | Y | All | – | Y, OS | P | PH | – | – | – | – | EXPC | – | Y | – | Y | Y | – | – | – | – |
| 1B | National Registry of Occupational diseases of | LV | The Centre of Occupational and Radiological | WC | Y | All | – | Y, OS | P | PH, IH, WO | – | – | – | – | EXPC | EXP | Y | Y Papers, symposia | Y | Y | – | – | – | – |

| Type | Surveillance system | Country | Type of organisation, institution | Aim of system | Aimed only at workers | Type of ODs reported | Region, sectors covered | Prescribed list of ODs | Passive or active surveillance | Who can report? | Reporting mechanism | Frequency of reporting | Data collected by the system | Information on exposure | Evaluation committee | Evaluation and analysis | Feedback to reporter | Dissemination of results; link with prevention | Follow-up of possible new/emerging risk | Collection of data into a database | Start date | End date | Formally evaluated | Website available |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Republic of Latvia | | Medicine of Pauls Stradins, Labour inspectorate | | | | | | | | | | | | | | | | | | | | | |
| 1B | Workers' Compensation and Welfare Service (COMWEL) | KOR | Korea Occupational Safety and Health Agency (KOSHA), Occupational Safety and Health Research Institute (OSHIRI) | WC, DC | Y | All | All, no CS, FA, FI, FOI, DEF, PUB | Y, OS | P | EMP | OB | – | – | – | EXP | EXP | – | – | – | – | 1964 | – | Y | – |
| 1B | Fund occupational diseases | BE | Insurance Fund — Fund occupational diseases | WC, PR | Y | All | All, no SE, DE | Y, OS | P | PH, WO | OB | – | Worker's gender, date of birth, age, occupation and sector, workplace address, exposures, diagnosis, symptoms, level of imputability | Y | EXP | EXP | N | N | N | N | 2000 | – | Y | Y |

| Type | Surveillance system | Country | Type of organisation, institution | Aim of system | Aimed only at workers | Type of ODs reported | Region, sectors covered | Prescribed list of ODs | Passive or active surveillance | Who can report? | Reporting mechanism | Frequency of reporting | Data collected by the system | Information on exposure | Evaluation committee | Evaluation and analysis | Feedback to reporter | Dissemination of results; link with prevention | Follow-up of possible new/emerging risk | Collection of data into a database | Start date | End date | Formally evaluated | Website available |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1B | Statistik Berufskrankheiten (Statistics of Occupational Diseases) | AT | Allgemeine Unfall-versicherungsanstalt (AUVA); Austrian Workers' Compensation Board | WC, PR, RS | Y | – | – | Y, OS | P | PH, EMP, WO | – | – | Demographic characteristics and administrative information on the patient, diagnosis, occupation, econor sector | N | – | – | – | – | – | – | – | – | Y | Y |
| 1C | Work Injury and Diseases Database (NWISP) | CA | Association of Workers' Compensation Boards of Canada (AWCBC) | WC | Y | – | – | N | P | – | – | – | Gender, age, nature of injury, part of the body, source of injury event, occupation, industry | – | – | – | – | – | – | Y | 1982 | – | Y | Y |
| 1C | PRESS-WORD | TW | Department of Health (DOH) | DC, ST, PR, WC | Y | All | – | N | P | PH | VOL | – | – | – | EXPC | EXP | Y | Y Seminars, statistics | Y | – | 1995 | 2007 | – | – |
| 1C | Safety & Health Assessment & Research for Prevention (SHARP) | WA | Washington State Department of | PR, DC | Y | WRSD | All | N | P | DM-WC | | C | Case information extracted from management syste claims | – | – | – | – | – | – | – | 1994 | – | – | Y |

| Type | Surveillance system | Country | Type of organisation, institution | Aim of system | Aimed only at workers | Type of ODs reported | Region, sectors covered | Prescribed list of ODs | Passive or active surveillance | Who can report? | Reporting mechanism | Frequency of reporting | Data collected by the system | Information on exposure | Evaluation committee | Evaluation and analysis | Feedback to reporter | Dissemination of results; link with prevention | Follow-up of possible new/emerging risk | Collection of data into a database | Start date | End date | Formally evaluated | Website available |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Dermatitis Program | | Labor and Industries | | | | | | | | | | | | | | | | | | | | | |
| 1C | Safety & Health Assessment & Research for Prevention (SHARP) Asthma Program | WA | Washington State Department of Labor and Industries | PR, DC | Y | WRA | All | N | P | PH, DM-WC | – | M | Cases are interviewed by phone to gather additional data, including information on workplace exposures and medical history | Y | – | – | – | – | Y | – | 2000 | – | – | Y |
| 1C | Safety & Health Assessment & Research for Prevention (SHARP) Musculoskeletal Disorders Program | WA | Washington State Department of Labor and Industries | PR, DC | Y | WR MSD | All | N | P | DM-WC | – | C | Case information extracted from management system's claims | – | – | – | – | – | – | – | 1991 | 1999 | – | Y |
| 1C + | Network of Occupational Diseases and Injuries Service (NODIS) | TW | Nine tertiary referral medical centres- Centres for | DC, ST, WC, PR | Y | All | All | N | P | OP | V OL | – | Worker's gender, age, industry and occupation, diagnosed disease(s), time | Y | EXP | EXP | – | Y Dissemination, | Y | – | 2007 | – | Y | Y |

| Type | Surveillance system | Country | Type of organisation, institution | Aim of system | Aimed only at workers | Type of ODs reported | Region, sectors covered | Prescribed list of ODs | Passive or active surveillance | Who can report? | Reporting mechanism | Frequency of reporting | Data collected by the system | Information on exposure | Evaluation committee | Evaluation and analysis | Feedback to reporter | Dissemination of results; link with prevention | Follow-up of possible new/emerging risk | Collection of data into a database | Start date | End date | Formally evaluated | Website available |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Occupational Disease and Injury Services (CODISs) | | | | | | | | | | of diagnosis, workplace exposure and hazards that caused the ailment | | | | | preventive actions | | | | | | |
| 2A | Occupational Physicians Reporting Activity (OPRA) | UK and IE | University of Manchester | DC, ST | Y | All | – | – | P | OP | V OL | M | Worker's gender, age, date of birth, occupational title and sector of professional activity, exposures, diagnosis, date of symptoms onset | Y | EXPC | LIT, EXP | Y | Y Papers, symposia website | Y | Y | 1996 | – | – | Y |
| 2A | THOR-GP | UK | University of Manchester | DC, ST | Y | All | – | – | P | GP | V OL | M | Worker's gender, age, date of birth, occupational title and sector, exposures, diagnosis, date of symptoms onset | Y | EXPC | LIT, EXP | Y | Y Papers, symposia, website | Y | Y | 2005 | – | – | Y |

| Type | Surveillance system | Country | Type of organisation, institution | Aim of system | Aimed only at workers | Type of ODs reported | Region, sectors covered | Prescribed list of ODs | Passive or active surveillance | Who can report? | Reporting mechanism | Frequency of reporting | Data collected by the system | Information on exposure | Evaluation committee | Evaluation and analysis | Feedback to reporter | Dissemination of results; link with prevention | Follow-up of possible new/emerging risk | Collection of data into a database | Start date | End date | Formally evaluated | Website available |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2A | MALattie PROFessionali (MALPROF) | IT | Italian Workers' Compensation Authority (INAIL) | DC, NER | Y | All | All | – | P | PH | OB | – | Worker's gender, age, date and place of birth, occupational title and sector, diagnosis | Y | EXP | LIT, EXP | N | Y Report, website | Y | Y | 2000 | – | Y | Y |
| 2A | Registry of WRD (Register for Arbeidsrelatert e Sykdommer (RAS)) | NO | Labour inspectorate | PR, DC, ST | Y | All | All, no PS, AV, MA | – | P | PH | OB | – | Worker's gender, age, date of birth, occupational title and sector, address, workplace address, exposures, diagnosis | Y | EXP | LIT, EXP | Y | Y Symposia, reports, WI, preventive actions | Y | Y | 1987 | – | N | Y |
| 2A | National Institute of Occupational Health (NIOH) registry | NO | National Institute of Occupational Health (NIOH) | DC | Y | All | All | – | P | PH | – | – | Demographic characteristics of the patient, information on disease, occupation, economic sector, exposure, level of imputability | Y | – | – | – | – | – | – | 2009 | – | Y | Y |

| Type | Surveillance system | Country | Type of organisation, institution | Aim of system | Aimed only at workers | Type of ODs reported | Region, sectors covered | Prescribed list of ODs | Passive or active surveillance | Who can report? | Reporting mechanism | Frequency of reporting | Data collected by the system | Information on exposure | Evaluation committee | Evaluation and analysis | Feedback to reporter | Dissemination of results; link with prevention | Follow-up of possible new/emerging risk | Collection of data into a database | Start date | End date | Formally evaluated | Website available |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2A | Surveillance programme of Work-Related Disease (MCP) | FR | French Institute for Public Health Surveillance (InVS) | DC, PR | Y | All | All, no CS, DE F | – | P | OP | V OL | 2 W /6 M | Worker's gender, age, date and place of birth, occupational title and sector, address, workplace address, exposures, diagnosis, symptoms, level of imputability | Y | EXPC | EXP | Y | Y | Y | Y | 2003 | – | Y | Y |
| 2A | National Occupational Disease Registry (NODR) | NL | Netherlands Center for Occupational Diseases (NCOD) | DC, ST | Y | All | All | – | P | OP | OB | – | Worker's gender, age, occupational title and sector of professional activity, exposures, diagnosis, symptoms | Y | REP | – | Y | Y Annual report | N | – | 1997 | – | Y | Y |
| 2A | Surveillance Project for Intensive Notification | NL | Netherlands Center for Occupational | DC, ST | Y | All | All | – | P | OP | V OL | – | Clinical diagnosis, age, gender, exposure (information on | Y | REP | – | Y | Y Annual report | N | Y | 2009 | – | Y | Y |

| Type | Surveillance system | Country | Type of organisation, institution | Aim of system | Aimed only at workers | Type of ODs reported | Region, sectors covered | Prescribed list of ODs | Passive or active surveillance | Who can report? | Reporting mechanism | Frequency of reporting | Data collected by the system | Information on exposure | Evaluation committee | Evaluation and analysis | Feedback to reporter | Dissemination of results; link with prevention | Follow-up of possible new/emerging risk | Collection of data into a database | Start date | End date | Formally evaluated | Website available |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (Peilstation Intensief Melden (PIM)) | | Diseases (NCOD) | | | | | | | | | | physical, chemical, biomechanical and psychosocial factors), occupation, economic sector and consequences for work ability | | | | | | | | | | | |
| 2A | Occupational Health Surveillance Program in Navarre | ES | Instituto Navarro de Salud Laboral (INSL) | DC, ST, PR | Y | All | All | – | P | PH | V OL | W | Administrative information on the patient, diagnosis, occupation, economic sector, do co-workers experience similar pathology, work absence | Y | EXP | EXP | Y | Y Newsletters, seminars, preventive actions | Y | Y | 1998 | – | Y | Y |
| 2A | Washington State Behavioral Risk Factor Surveillance | WA | Washington State Department of Labor and Industries, | DC, ST, RS | Y | All | All | – | P | WO | V OL | AN | Work Health Module is incorporated in Behavioural Risk Factor | – | N | – | – | – | – | – | 2002 | – | – | Y |

| Type | Surveillance system | Country | Type of organisation, institution | Aim of system | Aimed only at workers | Type of ODs reported | Region, sectors covered | Prescribed list of ODs | Passive or active surveillance | Who can report? | Reporting mechanism | Frequency of reporting | Data collected by the system | Information on exposure | Evaluation committee | Evaluation and analysis | Feedback to reporter | Dissemination of results; link with prevention | Follow-up of possible new/emerging risk | Collection of data into a database | Start date | End date | Formally evaluated | Website available |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | System (BRFSS) — Worker Health Module | | Centers for Disease Control and Prevention (CDC) | | | | | | | | | | Surveillance System (BRFSS) implemented across USA and consists of three modules: core questions, optional modules, state-added question | | | | | | | | | | | |
| 2A | Doctor's reporting of illness according to AFS 2005:6, § 11 | S W | Labour inspectorate — Swedish Working Environmental Authority | DC | Y | – | – | – | P | PH | – | – | – | – | EXP | EXP, LIT | Y | – | Y | N | – | – | – | – |
| 2A | Occupational Disease Surveillance and Reporting System (ODSRS) | CN | Institute of Occupational Health and Poisoning Control (IOHPC), Chinese Center for Disease Control and | DC | Y | – | All, no M W | – | P | PH | V OL | – | – | – | – | – | – | – | Y | – | 2006 | – | – | – |

| Type | Surveillance system | Country | Type of organisation, institution | Aim of system | Aimed only at workers | Type of ODs reported | Region, sectors covered | Prescribed list of ODs | Passive or active surveillance | Who can report? | Reporting mechanism | Frequency of reporting | Data collected by the system | Information on exposure | Evaluation committee | Evaluation and analysis | Feedback to reporter | Dissemination of results; link with prevention | Follow-up of possible new/emerging risk | Collection of data into a database | Start date | End date | Formally evaluated | Website available |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Prevention (CCDC) | | | | | | | | | | | | | | | | | | | | | |
| 2A+ | French National Occupational Diseases Surveillance and Prevention Network (RNV3P) | FR | The French Agency for Food, Environmental and Occupational Health & Safety (ANSES) | DC, NER | Y | All | All | – | P | OP+DM | VOL | – | Worker's gender, age, date and place of birth, occupational title and sector related to principal exposure, address, workplace address, principal exposure and other possible exposures, principal disease and comorbid diseases, level of imputability | Y | EXPC | EXP, LIT | Y | Y<br>Dissemination and prevention on several levels | Y | Y | 2001 | – | Y | Y |
| 2A+ | THOR-EXTRA | UK | University of Manchester | NER | Y | All | – | – | P | PH | VOL | – | Age, sex of patient, diagnosis, symptoms onset, | – | – | – | – | – | – | – | – | – | – | – |

| Type | Surveillance system | Country | Type of organisation, institution | Aim of system | Aimed only at workers | Type of ODs reported | Region, sectors covered | Prescribed list of ODs | Passive or active surveillance | Who can report? | Reporting mechanism | Frequency of reporting | Data collected by the system | Information on exposure | Evaluation committee | Evaluation and analysis | Feedback to reporter | Dissemination of results; link with prevention | Follow-up of possible new/emerging risk | Collection of data into a database | Start date | End date | Formally evaluated | Website available |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | occupation, industry, suspected agent, whether case is reported to THOR | | | | | | | | | | | |
| 2B | Surveillance of Work-Related and Occupational Respiratory Disease (SWORD) | UK and IE | University of Manchester | ST, RS, NER | Y | WRRD | – | – | P | CP | VOL | M | Worker's gender, age, date of birth, occupational title and sector, exposures, diagnosis, date of symptoms onset | Y | EXPC | EXP, LIT | Y | Y<br>Papers, symposia, website | Y | Y | 1989 | – | Y | Y |
| 2B | EPI-DERM | UK and IE | University of Manchester | ST, RS, NER | Y | WRSD | – | – | P | DER | VOL | M | Worker's gender, age, date of birth, occupational title and sector, exposures, diagnosis, date of symptoms onset | Y | EXPC | EXP, LIT | Y | Y<br>Papers, symposia, website | Y | Y | 1993 | – | – | Y |

| Type | Surveillance system | Country | Type of organisation, institution | Aim of system | Aimed only at workers | Type of ODs reported | Region, sectors covered | Prescribed list of ODs | Passive or active surveillance | Who can report? | Reporting mechanism | Frequency of reporting | Data collected by the system | Information on exposure | Evaluation committee | Evaluation and analysis | Feedback to reporter | Dissemination of results; link with prevention | Follow-up of possible new/emerging risk | Collection of data into a database | Start date | End date | Formally evaluated | Website available |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2B | Surveillance of Infectious Diseases At Work (SIDAW) | UK | University of Manchester | – | Y | WRI D | – | – | P | INF | V OL | M | Worker's gender, age, date of birth, occupational title and sector, exposures, diagnosis, date of symptoms onset | Y | EXPC | EXP, LIT | Y | Y Papers, symposia, website | Y | Y | 1996 | – | – | Y |
| 2B | Occupational Surveillance of Otorhinolaryngological Disease (THOR-ENT) | UK | University of Manchester | – | Y | WRO D | – | – | P | ORL | V OL | – | – | – | – | – | – | – | – | – | 2005 | 2006 | – | – |
| 2B | Musculoskeletal Occupational Surveillance Scheme for rheumatologists (MOSS) | UK | University of Manchester | – | Y | WR MSD | – | – | P | RHE | V OL | M | – | – | – | – | – | – | – | – | 1997 | 2009 | – | – |
| 2B | Occupational Surveillance Scheme for | UK | University of Manchester | – | Y | WRA D | – | – | P | AU | V OL | M | Worker's gender, age, date of birth, diagnosis, | – | – | – | – | – | – | – | 1997 | 2006 | – | – |

| Type | Surveillance system | Country | Type of organisation, institution | Aim of system | Aimed only at workers | Type of ODs reported | Region, sectors covered | Prescribed list of ODs | Passive or active surveillance | Who can report? | Reporting mechanism | Frequency of reporting | Data collected by the system | Information on exposure | Evaluation committee | Evaluation and analysis | Feedback to reporter | Dissemination of results; link with prevention | Follow-up of possible new/emerging risk | Collection of data into a database | Start date | End date | Formally evaluated | Website available |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Audiological physicians (OSSA) | | | | | | | | | | | | symptoms onset, exposure, occupation, economic sector | | | | | | | | | | | |
| 2B | Surveillance of Occupational Stress and Mental Illness (SOSMI) | UK | University of Manchester | – | Y | WR MD | – | – | P | PSY | V OL | M | – | – | – | – | – | – | – | – | 1999 | 2009 | – | – |
| 2B | Rare Respiratory Disease Registry Surveillance Scheme of Occupational Asthma (SHIELD) | UK | Midland Thoracic Society, West Midlands branch of the Society of Occupational Medicine | DC, ST | Y | WRA | All | – | P | CP, OP | OB | – | Demographic data, occupation, causative agents, employers, method of diagnosis, proposed mechanism, and employment state at time of diagnosis | Y | EXPC | – | – | Y<br>Annual report | – | – | 1989 | – | – | Y |
| 2B | Surveillance of Work-related and Occupational Respiratory | SA | National Centre for Occupational Health, the South African | DC, ST, PR | Y | WRR D | N O N-M, | – | P | PU, OP, OH N | V OL | M /Y | Disease, industry and job in which exposure occurred and putative | Y | REP | – | IN | Y<br>Papers, newsletters, | – | – | 1996 | 2006 | Y | Y |

| Type | Surveillance system | Country | Type of organisation, institution | Aim of system | Aimed only at workers | Type of ODs reported | Region, sectors covered | Prescribed list of ODs | Passive or active surveillance | Who can report? | Reporting mechanism | Frequency of reporting | Data collected by the system | Information on exposure | Evaluation committee | Evaluation and analysis | Feedback to reporter | Dissemination of results; link with prevention | Follow-up of possible new/emerging risk | Collection of data into a database | Start date | End date | Formally evaluated | Website available |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Diseases in South Africa (SORDSA) | | Pulmonology Society (SAPS), South African Society for Occupational Medicine (SASOM), South African Society for Occupational Health Nurses (SASOHN) and the Department of Labour | | | | EX -M | | | | | | causative agent; a more detailed form for each case of occupational asthma collected, further information including method of diagnosis and history of patient | | | | | brochures | | | | | | |
| 2B | Surveillance of Australian workplace Based Respiratory Events (SABRE) | AUS | Workers' Compensation (Dust Diseases) Board of NSW and Monash University | DC, ST | Y | WRRD | – | – | P | PU, OP, GP | VOL | 2M/Y | Gender, smoking history, present occupation and occupation thought to have caused the disease (if different), | Y | REP | – | N | Y Papers, symposia | N | Y | 1997 (in VI, TA), 2001 (in NSW) | 2008 (in NSW) | N | N |

| Type | Surveillance system | Country | Type of organisation, institution | Aim of system | Aimed only at workers | Type of ODs reported | Region, sectors covered | Prescribed list of ODs | Passive or active surveillance | Who can report? | Reporting mechanism | Frequency of reporting | Data collected by the system | Information on exposure | Evaluation committee | Evaluation and analysis | Feedback to reporter | Dissemination of results; link with prevention | Follow-up of possible new/emerging risk | Collection of data into a database | Start date | End date | Formally evaluated | Website available |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Melbourne Australia | | | | | | | | | | industry, location of industry (postcode), presumed agent and diagnosis | | | | | | | | | | | |
| 2B | Ontario Work-Related Asthma Surveillance System (OWRAS) | CA | – | DC, ST | Y | WRA, WRB, WRR, WRSC | All | – | P | PU, OP, AL | VOL | M | Initials, year of birth, occupation, suspected exposure(s), symptoms smoking status, and whether claim had been submitted to the Workplace Safety and Insurance Board | Y | REP | – | Y | – | – | – | 2007 | End ed | – | – |
| 2B | Physician based surveillance system for occupational respiratory | CA—QU | Montreal Public Health Department, Occupational and Environmental Health Unit | DC | Y | WRRD | – | – | P | CP, AL | VOL | M | Worker's age, sex, tobacco smoking, occupation, type of industry, causal agent suspected by reporting | – | – | – | – | – | – | – | 1992 | 1993 | Y | – |

| Type | Surveillance system | Country | Type of organisation, institution | Aim of system | Aimed only at workers | Type of ODs reported | Region, sectors covered | Prescribed list of ODs | Passive or active surveillance | Who can report? | Reporting mechanism | Frequency of reporting | Data collected by the system | Information on exposure | Evaluation committee | Evaluation and analysis | Feedback to reporter | Dissemination of results; link with prevention | Follow-up of possible new/emerging risk | Collection of data into a database | Start date | End date | Formally evaluated | Website available |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | diseases (PROPULSE) | | | | | | | | | | | | physician, whether patient was covered by Workers' Compensation Board | | | | | | | | | | | |
| 2B | Surveillance programme for occupational lung diseases | CA — BC | Occupational and Environmental Lung Diseases Research Unit of the Department of Medicine, University of British Columbia | DC | Y | WRR D | – | – | P | PU, TS, OP, GP, INT | V OL | 2 M | Surname and first initial, sex, age, city or town of residence, job, type of industry, suspected agent | Y | – | – | – | – | – | – | 1991 | 1992 | Y | – |
| 2B | Voluntary registry of occupational respiratory diseases in Asturias, Catalonia and Navarre | ES | Instituto Navarro de Salud Laboral (INSL) | – | Y | WRR D | – | – | P | PH | V OL | 2 M | Sex, age, smoking status, workplace where disease occurred, work sector, occupation, suspected causal agent, estimated probability of | – | – | – | – | – | – | – | 2002 (AS, CAT, NA) | 2004 (AS) | Y | – |

| Type | Surveillance system | Country | Type of organisation, institution | Aim of system | Aimed only at workers | Type of ODs reported | Region, sectors covered | Prescribed list of ODs | Passive or active surveillance | Who can report? | Reporting mechanism | Frequency of reporting | Data collected by the system | Information on exposure | Evaluation committee | Evaluation and analysis | Feedback to reporter | Dissemination of results; link with prevention | Follow-up of possible new/emerging risk | Collection of data into a database | Start date | End date | Formally evaluated | Website available |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | certainty of suspected diagnosis | | | | | | | | | | | |
| 2B | Korea Work-related Asthma Surveillance (KOWAS) program | KOR | Occupational Safety and Health Research Institute of the Korea Occupational Safety and Health Agency (OSHRI-KOSHA) | DC | Y | WRA | – | – | P | CP, AL, OP | – | – | Sex, age, address, occupation type, and exposure duration, suspected causal agent, dates of asthma onset and diagnosis, whether it was new-onset versus exacerbation of pre-existing asthma, whether objective diagnostic tests had been conducted | – | – | – | – | – | – | – | 2004 | | Y | – |
| 2B | Observatoire National des Asthmes | FR | French Institute for Public Health | DC, PR | Y | WRA | – | – | P | OP, CP | V OL | – | Worker's gender, age, date and place of birth, occupational title | Y | EXPC | – | – | – | – | Y | 2008 | Y | Y | – |

| Type | Surveillance system | Country | Type of organisation, institution | Aim of system | Aimed only at workers | Type of ODs reported | Region, sectors covered | Prescribed list of ODs | Passive or active surveillance | Who can report? | Reporting mechanism | Frequency of reporting | Data collected by the system | Information on exposure | Evaluation committee | Evaluation and analysis | Feedback to reporter | Dissemination of results; link with prevention | Follow-up of possible new/emerging risk | Collection of data into a database | Start date | End date | Formally evaluated | Website available |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Professionnels (ONAP2) | | Surveillance (InVS) | | | | | | | | | | and sector of professional activity, address, workplace address, exposures, diagnosis, symptoms, level of imputability | | | | | | | | | | | |
| 2B | French registry of workers handling engineered nanomaterials (EpiNano) | FR | French Institute for Public Health Surveillance (InVS) | DC, PR, NER | Y | NM | – | – | P | OP, SHI | V OL | – | Past occupational history and associated exposure, items on health status and anamnesis, lifestyle and habits such as smoking, alcohol consumption and physical activity | WI | EXP | EXP | Y | Y Reports, papers, preventive actions | Y | Y | 2013 | – | N | Y |
| 2B | Italian Occupational Cancer Monitoring Information | IT | National Institute for Occupational Health (ISPESL), | DC, PR | Y | OCA | – | – | P | ILC, CCS | V OL | – | Medical data from cancer registries/regional hospital discharge | Y | – | LIT | – | Y Publications | – | Y | 2000 | – | – | Y |

| Type | Surveillance system | Country | Type of organisation, institution | Aim of system | Aimed only at workers | Type of ODs reported | Region, sectors covered | Prescribed list of ODs | Passive or active surveillance | Who can report? | Reporting mechanism | Frequency of reporting | Data collected by the system | Information on exposure | Evaluation committee | Evaluation and analysis | Feedback to reporter | Dissemination of results; link with prevention | Follow-up of possible new/emerging risk | Collection of data into a database | Start date | End date | Formally evaluated | Website available |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | System (OCCAM) | | Italian National Cancer Institute in Milano | | | | | | | | | | records, employment histories, consisting of names of companies worked for, industrial sector codes, and periods of employment, obtained by automatic linkage to Social Security (INPS) files | | | | | | | | | | | | |
| 2C | Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR) | UK | – | PR | Y | PL | – | Y | P | EMP, SE | OB | – | Information on employee and workplace, information regarding incident, injured person, questions about injury, one free | – | – | – | – | Y | – | Y | 1996 | – | – | Y |

| Type | Surveillance system | Country | Type of organisation, institution | Aim of system | Aimed only at workers | Type of ODs reported | Region, sectors covered | Prescribed list of ODs | Passive or active surveillance | Who can report? | Reporting mechanism | Frequency of reporting | Data collected by the system | Information on exposure | Evaluation committee | Evaluation and analysis | Feedback to reporter | Dissemination of results; link with prevention | Follow-up of possible new/emerging risk | Collection of data into a database | Start date | End date | Formally evaluated | Website available |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | text question about accident | | | | | | | | | | | |
| 2C | iReport; one-stop reporting platform for occupational accidents, injuries and diseases | SI | Ministry of Manpower (MOM) | DC | Y | PL | All, no SE, DW, DEF | Y | P | PH, EMP, WO | OB | - | Demographic characteristics and administrative information on patient, details on OD, exposure | Y | EXP | EXP | – | – | – | – | 2006 | – | – | Y |
| 3A | Sentinel Event Notification System for Occupational Risks (SENSOR) | USA | National Institute for Occupational Safety and Health (NIOSH), Centers for Disease Control and Prevention (CDC) | PR, DC, ST | Y | Vary from state to state | – | – | P | PH | – | – | Detailed work and medical histories, including work-relatedness information | Y | EXP | EXP | IN | Y Publications, case reports, preventive actions | Y | – | 1987 | – | Y | Y |
| 3A | NIOSH Health Hazard Evaluation (HHE) Program | USA | National Institute for Occupational Safety and | PR, NER | Y | All | – | – | P | EMP, WO | VOL | – | Administrative information on employee, workplace name | WI | EXPC | EXP | Y | Y Website, searchable | Y | Y | 1971 | – | Y | Y |

| Type | Surveillance system | Country | Type of organisation, institution | Aim of system | Aimed only at workers | Type of ODs reported | Region, sectors covered | Prescribed list of ODs | Passive or active surveillance | Who can report? | Reporting mechanism | Frequency of reporting | Data collected by the system | Information on exposure | Evaluation committee | Evaluation and analysis | Feedback to reporter | Dissemination of results; link with prevention | Follow-up of possible new/emerging risk | Collection of data into a database | Start date | End date | Formally evaluated | Website available |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Health (NIOSH) | | | | | | | | | | and address, work description, number of employees, exposure, information on person responsible for employee health and safety at workplace, exposure levels, health outcomes, controls present (engineering, administrative, and personal protective equipment) | | | | | database, preventive actions | | | | | | | |
| 3A+ | SIGNAAL | NL B | NCOD, KU Leuven, Idewe | AW | Y | All | – | – | P | PH OP IH | VOL | – | Age, gender of worker, description of health complaints, diagnoses, diagnostic testing, job | Y | EXPC | EXP LIT | Y | Y Case reports | Y | Y | 2013 | – | Y | Y |

| Type | Surveillance system | Country | Type of organisation, institution | Aim of system | Aimed only at workers | Type of ODs reported | Region, sectors covered | Prescribed list of ODs | Passive or active surveillance | Who can report? | Reporting mechanism | Frequency of reporting | Data collected by the system | Information on exposure | Evaluation committee | Evaluation and analysis | Feedback to reporter | Dissemination of results; link with prevention | Follow-up of possible new/emerging risk | Collection of data into a database | Start date | End date | Formally evaluated | Website available |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | description, industrial sector, exposure, protective measures and equipment, work-relatedness | | | | | | | | | | | |
| 3A+ | OccWatch: Occupational Diseases Sentinel Clinical Watch System project | FR | Research organisation, Modernet network (Monitoring Occupational Diseases and Emerging Risks New Network) | AW | Y | All | – | N | P | PH OP | VOL | – | Demographic characteristics, principal disease and comorbid diseases, principal exposure and other possible exposures, occupational title and sector of professional activity, additional informative documents | Y | EXP | EXP LIT | Y | Y Relevant stakeholders | Y | Y | 2013 | – | – | Y |
| 3A+ | GAST: Occupational | FR | French Institute for Public Health | AW | Y | All with focu | F | N | P | Any one | VOL | – | Diagnosis or symptoms, number of cases, | Y | EXPC | EXP | Y | – | Y | Y | 2008 | – | – | Y |

| Type | Surveillance system | Country | Type of organisation, institution | Aim of system | Aimed only at workers | Type of ODs reported | Region, sectors covered | Prescribed list of ODs | Passive or active surveillance | Who can report? | Reporting mechanism | Frequency of reporting | Data collected by the system | Information on exposure | Evaluation committee | Evaluation and analysis | Feedback to reporter | Dissemination of results; link with prevention | Follow-up of possible new/emerging risk | Collection of data into a database | Start date | End date | Formally evaluated | Website available |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Health Warning Groups | | Surveillance (InVS) | | | s on unusual events | | | | | | | occupational exposure of cases, demographic information in enterprise/public institution | | | | | | | | | | | |
| 3A+ | Notifiable Occupational Disease System (NODS) | NZ | WorkSafe New Zealand | AW PR RS | Y | All | – | N | P | PH, OHN, EMP, WO | VOL | – | Name, age, gender of patient, details regarding occupational disease, exposure, industry, work-relatedness, employer | Y | EXPC | EXP | N | Y Reports | Y | Y | 1992 | – | Y | Y |
| 3B | State-based surveillance and intervention programs for WRA (part of SENSOR) | USA | National Institute for Occupational Safety and Health (NIOSH), Centers for Disease Control and | PR | Y | WRRD | Four states | N | P | PH, HOS | OB | – | Surveillance staff members collect additional information (e.g. detailed work and medical histories, including work- | Y | EXPC | – | – | Y Newsletters | Y | – | 1987; California — 1992 | – | Y | Y |

| Type | Surveillance system | Country | Type of organisation, institution | Aim of system | Aimed only at workers | Type of ODs reported | Region, sectors covered | Prescribed list of ODs | Passive or active surveillance | Who can report? | Reporting mechanism | Frequency of reporting | Data collected by the system | Information on exposure | Evaluation committee | Evaluation and analysis | Feedback to reporter | Dissemination of results; link with prevention | Follow-up of possible new/emerging risk | Collection of data into a database | Start date | End date | Formally evaluated | Website available |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Prevention (CDC) | | | | | | | | | | relatedness information) | | | | | | | | | | | |
| 3B | SENSOR Pesticides Program | USA | National Institute for Occupational Safety and Health (NIOSH), California Department of Pesticide Regulation (CDPR), Environmental Protection Agency (EPA), Office of Pesticides Programs (OPP), American Association of Poison Control Centers (AAPCC) | DC, ST, RS | Y | Pesticide related illness | 11 US States | N | P | PH | – | – | Surveillance staff members collect additional information related to individual cases | – | – | – | – | Y<br>Case reports | – | Y | – | – | – | Y |

| Type | Surveillance system | Country | Type of organisation, institution | Aim of system | Aimed only at workers | Type of ODs reported | Region, sectors covered | Prescribed list of ODs | Passive or active surveillance | Who can report? | Reporting mechanism | Frequency of reporting | Data collected by the system | Information on exposure | Evaluation committee | Evaluation and analysis | Feedback to reporter | Dissemination of results; link with prevention | Follow-up of possible new/emerging risk | Collection of data into a database | Start date | End date | Formally evaluated | Website available |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3B | Cancer Panel | NZ | Department of Labour (DoL) | REV | Y | WRCA | – | N | P | Cases from registers | VOL | – | Demographic and diagnostic information combined with detailed occupational and exposure histories gathered through interviews with individual patients | Y, WI | EXPC | EXP | Y | Y Case studies | Y | y | – | End ed | – | – |
| 3B | Respiratory Diseases Panel (The former Asthma and Asbestos Panels) | NZ | WorkSafe New Zealand | REV | Y | WRRD | – | N | P | Cases from registers | VOL | – | Information notified to WorkSafe New Zealand combined with detailed medical records | Y, WI | EXPC | EXP | Y | Y Annual report | – | – | 2001 | – | – | – |
| 3B | Solvent Panel | NZ | Department of Labour (DoL) | REV | Y | WRDs related to | – | N | P | Cases from regi | VOL | | Notified information combined with detailed occupational and | Y, WI | EXPC | EXP | – | Y Case studies | – | – | – | End ed | – | Y |

| Type | Surveillance system | Country | Type of organisation, institution | Aim of system | Aimed only at workers | Type of ODs reported | Region, sectors covered | Prescribed list of ODs | Passive or active surveillance | Who can report? | Reporting mechanism | Frequency of reporting | Data collected by the system | Information on exposure | Evaluation committee | Evaluation and analysis | Feedback to reporter | Dissemination of results; link with prevention | Follow-up of possible new/emerging risk | Collection of data into a database | Start date | End date | Formally evaluated | Website available |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | solvents | | | | sters | | | exposure histories gathered through interviews with patients and workplace inspection (if necessary) | | | | | | | | | | | |
| 3B | Chemical Panel | NZ | Department of Labour (DoL) | REV | Y | WRDs related to chemicals | – | – | P | – | VOL | – | Notified information combined with detailed occupational and exposure histories gathered through interviews with patients and workplace inspection (if necessary) | Y, WI | EXPC | EXP | – | – | – | – | – | Ended | – | – |
| 4A | Self-reported Work-related Illness survey | UK | – | DC, ST | N | All | – | N | A | WO | VOL | QUA | Information on disease, symptoms, | Y | N | N | N | – | N | – | 2001 | – | – | Y |

| Type | Surveillance system | Country | Type of organisation, institution | Aim of system | Aimed only at workers | Type of ODs reported | Region, sectors covered | Prescribed list of ODs | Passive or active surveillance | Who can report? | Reporting mechanism | Frequency of reporting | Data collected by the system | Information on exposure | Evaluation committee | Evaluation and analysis | Feedback to reporter | Dissemination of results; link with prevention | Follow-up of possible new/emerging risk | Collection of data into a database | Start date | End date | Formally evaluated | Website available |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (SWI) (module of the Labour Force Survey (LFS)) | | | | | | | | | | | | exposure, occupation, economic sector, work absence | | | | | | | | | | | |
| 4A | Quarterly National Household Survey (QNHS) | IE | The Central Statistics Office (CSO) | DC, ST | N | All | RGs | N | A | WO | VOL | QUA | Disease, symptoms, exposure, occupation, economic sector, work absence, factors at work that can adversely affect mental well-being or physical health | Y | N | N | N | Y Tables | N | Y | 1997 | – | Y | Y |
| 4B | Pesticide Illness Surveillance Program (PISP) | USA | California Department of Pesticide Regulation (CDPR) | PR, DC, RS | N | Acute pesticide-related illness and | – | – | P | PH, OO HOS | OB | – | Demographic and administrative information, diagnosis, symptoms, occupation, employer, | Y | EXPC | EXP | – | – | – | Y | 1971 | – | – | – |

| Type | Surveillance system | Country | Type of organisation, institution | Aim of system | Aimed only at workers | Type of ODs reported | Region, sectors covered | Prescribed list of ODs | Passive or active surveillance | Who can report? | Reporting mechanism | Frequency of reporting | Data collected by the system | Information on exposure | Evaluation committee | Evaluation and analysis | Feedback to reporter | Dissemination of results; link with prevention | Follow-up of possible new/emerging risk | Collection of data into a database | Start date | End date | Formally evaluated | Website available |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | injury | | | | | | | exposure laboratory tests | | | | | | | | | | | |
| 4B | Programme de surveillance des troubles musculo-squelettiques (TMS) | FR | French Institute for Public Health Surveillance (InVS) | PR, DC | N | MSD | – | N | P | PH, MS, OP | V OL | – | Gender, age, date/place of birth, occupational title and sector, exposures, diagnosis, symptoms | Y | – | – | – | – | – | – | 2002 | – | – | Y |
| 4B | The French National Program for Mesothelioma Surveillance (PNSM) | FR | French Institute for Public Health Surveillance (InVS) | PR, DC | N | CA (Mesothelioma), WR + NWR | 21/22 districts 30 % of population | Y | P | MS, OP | V OL | – | Worker's gender, age, date and place of birth, occupational title and sector, address, workplace address, exposures, duration of exposure, diagnosis | Y | – | – | – | – | – | – | 1998 | – | – | Y |

| Type | Surveillance system | Country | Type of organisation, institution | Aim of system | Aimed only at workers | Type of ODs reported | Region, sectors covered | Prescribed list of ODs | Passive or active surveillance | Who can report? | Reporting mechanism | Frequency of reporting | Data collected by the system | Information on exposure | Evaluation committee | Evaluation and analysis | Feedback to reporter | Dissemination of results; link with prevention | Follow-up of possible new/emerging risk | Collection of data into a database | Start date | End date | Formally evaluated | Website available |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4B | Melioidosis surveillance system | USA | Bacterial Special Pathogens Branch, National Center for Emerging and Zoonotic Infectious Diseases | PR | N | ID, Melioidosis | – | Y | P | PH, LAB | VOL | – | Demographic information, signs and symptoms, diagnosis, travel history, country of birth, risk factors, data from occupational exposures | Y | – | – | – | – | Y | – | 2008 | – | – | – |
| 4B | Notification by clinicians and hospitals on infectious diseases | IE | The Health Protection Surveillance Centre (HPSC) | DC, PR | N | ID (PL, WR + NWR) | – | Y | P | PH | OB | – | If work-related, 'enhanced' form is required, including risk factors, e.g. health care worker and exposure data | Y | – | – | – | – | – | – | – | – | – | Y |

# 11 Appendix C — Table of system codes

| System type | Code |
|---|---|
| Compensation-based national systems linked to workers' compensation system | 1 |
| ▪ with a prescribed list of ODs that can be reported for compensation | 1A |
| ▪ with a list of ODs but also a complementary open list in which proof of the work-relatedness of the disease is required | 1B |
| ▪ like 1B but also aimed at identifying new/emerging work-related health problems | 1B+ |
| ▪ where a claim could be filed without a prescribed list | 1C |
| ▪ like 1C but also aimed at identifying new/emerging work-related health problems | 1C+ |
| ▪ **Non-compensation-related systems primarily designed for data collection and statistics** | 2 |
| ▪ aimed at all work-related or occupational diseases | 2A |
| ▪ like 2A but also aimed at identifying new/emerging work-related health problems | 2A+ |
| ▪ focused on one or a subset of work-related or occupational diseases | 2B |
| ▪ focused on work-related injuries, accidents and diseases | 2C |
| ▪ **Sentinel systems** | **3** |
| ▪ focused on all work-related or occupational diseases | 3A |
| ▪ like 3A but also aimed at identifying new/emerging work-related health problems | 3A+ |
| ▪ focused on one or a subset of work-related or occupational diseases | 3B |
| ▪ **Public health surveillance systems covering the general population, including workers** | **4** |
| ▪ aimed at monitoring all work-related or occupational diseases | 4A |
| ▪ aimed at monitoring one or a subset of work-related or occupational diseases | 4B |

# 12 References

Aagaard, L., and Hansen, E.H., 2009. Information about ADRs explored by pharmacovigilance approaches: a qualitative review of studies on antibiotics, SSRIs and NSAIDs. *BMC clinical pharmacology*, 9, p. 4. Available at: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2656469&tool=pmcentrez&rendertype=abstract [Accessed 18 May 2017].

Spreeuwers, D., de Boer, A., Verbeek, J., van der Laan, G., Lenderink, A., Braam, I., van Beurden, M., and van Dijk, F., 2008. Time trends and blind spots: what employers, employees and policy-makers want to know about occupational diseases. *Policy and Practice in Health and Safety*, 6(1), pp. 65-78.

Aw, T.C., and Koh, D., 2003. Surveillance in Occupational Health. *Occupational and Environmental Medicine,* 60, pp. 705-710.

Baker, E.L., 1989. Sentinel Event Notification System for Occupational Risks (SENSOR): the concept. *American journal of public health*, 79 Suppl, pp. 18-20. Available at: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1350124&tool=pmcentrez&rendertype=abstract [Accessed 18 May 2017].

Bonneterre, V., Bicout, D.J., Larabi, L, Bernardet, C., Maitre, A., Tubert-Bitter, P., and de Gaudemaris, R., 2008. Detection of emerging diseases in occupational health: usefulness and limitations of the application of pharmacosurveillance methods to the database of the French National Occupational Disease Surveillance and Prevention network (RNV3P). *Occupational and Environmental Medicine*, 65(1), pp. 32-37. Available at: http://www.ncbi.nlm.nih.gov/pubmed/17728406 [Accessed 18 May 2017].

Bonneterre, V., Faisandier, L., Bicout, D., Bernardet, C., Piollat, J., Ameille, J., de Clavière, C., Aptel, M., Lasfargues, G., de Gaudemaris, R, and RNV3P, 2010. Programmed health surveillance and detection of emerging diseases in occupational health: contribution of the French national occupational disease surveillance and prevention network (RNV3P). *Occupational and Environmental Medicine*, 67(3), pp. 178-186. Available at: http://oem.bmj.com/content/67/3/178 [Accessed 18 May 2017].

Bonneterre, V., Bicout, D.J., and de Gaudemaris, R., 2012. Application of pharmacovigilance methods in occupational health surveillance: comparison of seven disproportionality metrics. *Safety and Health at Work*, 3(2), p. 92.

Bonneterre, V., Faye S., and Le Barbier, M., 2013. Occupational diseases sentinel clinical watch system project : a model to be generalised? Presented at the conference: 'Occupational Diseases in the EU. The system(s) and their role. "Together for disease-free workers"', December 4, 2013, Brussels, Belgium.

Boutou-Kempf, O., Marchand, J-L., Radauceanu, A., Witschger, O., Imbernon, E., and the group on Health Risks of Nanotechnologies, 2011. Development of a French epidemiological surveillance system of workers producing or handling engineered nanomaterials in the workplace. *Journal of Occupational and Environmental Medicine*, 53(6), pp.S103-S107. Available at: http://content.wkhealth.com/linkback/openurl?sid=WKPTLP:landingpage&an=00043764-201106001-00023 [Accessed 18 May 2017].

Calvert, G.M., Mehler, L.N., Alsop, J., De Vries, A.L., and Besbelli, N., 2010.Surveillance of pesticide-related illness and injury in humans. In: Hayes' Handbook of Pesticide Toxicology (Krieger, R.I., ed). 3rd ed. New York: Elsevier, 1313-1369. Available at: http://www.sciencedirect.com/science/article/pii/B9780123743671000616 [Accessed 18 May 2017].

Campo, G., Papale, A., Baldasseroni, A., Di Leone, G., Magna, B., and Mattioli, S., 2015. The surveillance of occupational diseases in Italy: the MALPROF system. *Occupational Medicine*, 65(8), pp. 632-637.

Carder, M.,Bensefa-Colas, L., Mattioli, S., Noone, P., Stikova, E., Valenty, M., and Telle-Lamberton, M., 2015. A review of occupational disease surveillance systems in Modernet countries. *Occupational Medicine*, 65(8), pp. 615-625. Available at: http://occmed.oxfordjournals.org/lookup/doi/10.1093/occmed/kqv081 [Accessed 18 May 2017].

Chu, P.C., Fuh, H.R., Luo, J.C., Du, C.L., Chuang, H.Y., Guo, H.R., Liu, C.S., Su, C.T., Tang, F.C., Chen, C.C., Yang, H.Y., and Guo, Y.L., 2013. The impact of occupational health service network and reporting system in Taiwan. *International Journal of Occupational and Environmental Health*, 19(4), pp. 352-362.

Contreras, G.R., Rousseau, R., and Chan-Yeung, M., 1994. Occupational respiratory diseases in British Columbia, Canada in 1991. *Occupational and Environmental Medicine*, 51(10), pp. 710-712. Available at: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1128082&tool=pmcentrez&rendertype=abstract [Accessed 18 May 2017].

Crosignani, P., Massari, S., Audisio, R., Amendola, P., Cavuto, S., Scaburri, A., Zambon, P., Nedoclan, G., Stracci, F., Pannelli, F., Vercelli, M., Miligi, L., Imbriani, M., and Berrino, F., 2006. The Italian surveillance system for occupational cancers: characteristics, initial results, and future prospects. *American Journal of Industrial Medicine*, 49(9), pp. 791-798.

Driscoll, T., Takala, J., Steenland, K., Corvalan, C., and Fingerhut, M., 2005. Review of estimates of the global burden of injury and illness due to occupational exposures. *American Journal of Industrial Medicine*, 48(6), pp. 491-502. Available at: http://www.ncbi.nlm.nih.gov/pubmed/16299705 [Accessed 18 May 2017].

Drummond, A., 2008. A Review of the Occupational Diseases Reporting System in the Republic of Ireland. p. 113. University College Dublin and the Health and Safety Authority, Dublin, 2008. Available at: http://www.hsa.ie/eng/Publications_and_Forms/Publications/Research_Publications/A_Review_of_the_Occupational_Diseases_Reporting_System_in_the_Republic_of_Ireland.pdf [Accessed 18 May 2017].

European Commission, 2003. Commission Recommendation of 19th September 2003 concerning the European schedule of occupational diseases (2003/670/EC). Available at: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2003.238.01.0028.01.ENG&toc=OJ:L:2003:238:TOC [Accessed 18 May 2017].

European Commission, 2007. Community strategy 2007-2012 on health and safety at work. Available at: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52007DC0062 [Accessed 18 May 2017].

European Commission, 2013. Report on the current situation in relation to occupational diseases' systems in EU Member States and EFTA/EEA countries, in particular relative to Commission Recommendation 2003/670/EC concerning the European Schedule of Occupational Diseases and Gathering of Data on Relevant Related Aspects. Available at: http://ec.europa.eu/social/BlobServlet?docId=9982&langId=en [Accessed 18 May 2017].

European Commission, 2014. EU Occupational Safety and Health (OSH) Strategic Framework 2014-2020. Available at: http://ec.europa.eu/social/main.jsp?catId=151 [Accessed 18 May 2017].

The European Parliament and the Council of the European Union, 2008. Regulation (EC) No 1338/2008 of the European Parliament and of the Council of 16 December 2008 on Community statistics on public health and health and safety at work. *Official Journal of the European Union*. Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:354:0070:0081:EN:PDF [Accessed 18 May 2017].

European Parliament, 2011. Report on the mid-term review of the European strategy 2007-2012 on health and safety at work (2011/2147(INI)). Available at: http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+REPORT+A7-2011-0409+0+DOC+XML+V0//EN [Accessed 18 May 2017].

European Monitoring Centre for Drugs and Drug Addiction, 2005. Monitoring new drugs. Available at:

http://www.emcdda.europa.eu/system/files/publications/408/Monitoring_new_drugs_72902.pdf [Accessed 18 May 2017].

EU-OSHA., 2005. Expert forecast on emerging physical risks related to occupational safety and health. Available at: https://osha.europa.eu/en/tools-and-publications/publications/reports/6805478 [Accessed 18 May 2017].

Fortenberry, G.Z., Beckman, J., Schwartz, A., Prado, J.B., Graham, L.S., Higgins, S., Lackovic, M., Mulay, P., Bojes, H., Waltz, J., Mitchell, Y., Leinenkugel, K., Oriel, M.S., Evans, E., and Calvert, G.M., 2016. Magnitude and characteristics of acute paraquat- and diquat-related illnesses in the US: 1998-2013. *Environmental Research*, 146, pp. 191-199. Available at: https://www.ncbi.nlm.nih.gov/pubmed/26775000 [Accessed 18 May 2017].

Godderis, L., Mylle, G., Coene, M., Verbeek, C., Viaene, B., Bulterys, S., and Schouteden, M., 2015. Data warehouse for detection of occupational diseases in OHS data. *Occupational Medicine*, 65(8), pp. 651-658.

Hannaford-Turner, K., Elder, D., Sim, M.R., Abramson, M.J., Johnson, A.R., and Yates, D.H., 2010. Surveillance of Australian workplace Based Respiratory Events (SABRE) in New South Wales. *Occupational Medicine*, 60(5), pp. 376-382.

Health Outcomes International PTY LTD, King, J., Nibbert, P., Butt, H., and Schulz, L., 2005. Methods and systems used to measure and monitor occupational disease and injury in New Zealand: NOHSAC technical report 2. Available at: https://www.worksafe.govt.nz/worksafe/about/publications/nohsac-reports/technical-report-02.pdf [Accessed 18 May 2017].

Hnizdo, E., Esterhuizen, T.M., Rees, D., and Lalloo, U.G., 2001. Occupational asthma as identified by the surveillance of work-related and occupational respiratory diseases programme in South Africa. *Clinical and Experimental Allergy*, 31(1), pp. 32-39.

International Labour Organization, 1993. Proceedings of the International Symposium on Work-Related Diseases: Prevention and Health Promotion (October 1992). ILO, Linz, 1993.

International Labour Organization, 2002. Recommendation concerning the List of Occupational Diseases and the Recording and Notification of Occupational Accidents and Diseases (No. 194). Available at: http://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:12100:0::NO::P12100_INSTRUMENT_ID:312532 [Accessed 18 May 2017].

International Labour Organization, 2010. Recommendation concerning the List of Occupational Diseases and the Recording and Notification of Occupational Accidents and Diseases. Annex: ILO list of occupational diseases (revised 2010). International Labour Conference. Available at: http://www.ilo.org/wcmsp5/groups/public/---ed_protect/---protrav/---safework/documents/publication/wcms_125137.pdf [Accessed 18 May 2017].

L'Agence régionale de santé, 1996. Programme Médicalisé des Systèmes d'Information (PMSI). Available at: http://www.ars.iledefrance.sante.fr/Programme-Medicalise-des-Syste.81555.0.html [Accessed 18 May 2017].

Lakes, G., Health, B., and Falls, N., 2007. The European Union Early Warning and Response System (EWRS) Establishment of the EWRS. Presented at the Great Lakes Border Health Initiative 2007 Conference, June 14-15, 2007, Niagara Falls, New York. Available at: https://www.michigan.gov/documents/mdch/SURVEILLANCE_INTERNATIONALE_-_MAIER_199748_7.pdf [Accessed 18 May 2017].

Lenderink, A.F., Keirsbilck, S., van der Molen, H.F., and Godderis, L., 2015. Online reporting and assessing new occupational health risks in SIGNAAL. *Occupational Medicine*, 65(8), pp. 638-641. Available at: http://occmed.oxfordjournals.org/lookup/doi/10.1093/occmed/kqv061 [Accessed 18 May 2017].

Marucci-Wellman, H., ScD, and Liberty Mutual Research Institute for Safety, 2009. Methodological Challenges in the Liberty Mutual Workplace Safety Index: Working Towards a Future Model. Proceedings from the workshop: Use of Workers' Compensation Data for Occupational Injury & Illness Prevention, pp. 29-36, September 22-23, 2009, Washington, D.C.

Mattioli, S., Zanardi F., Baldasseroni, A., Schaafsma, F., Cooke, R.M.T., Mancini, G., Fierro, M., Santangelo, C., Farioli, A., Fucksia, S., Curti, S., Violante, F.S., and Verbeek, J., 2010. Search strings for the study of putative occupational determinants of disease. *Occupational and Environmental Medicine*, 67(7), pp.436-443. Available at: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2989170&tool=pmcentrez&rendertype=abstract [Accessed 18 May 2017].

Harremoës, P., Gee, D., MacGarvin, M., Stirling, A., Keys, J., Wynne, B., and Vaz, S.G , 2001. *Late lessons from early warnings: the Precautionary Principle 1896-2000*. European Environment Agency, Copenhagen.

McDonald, J.C., Chen, Y., Zekveld, C., and Cherry, N., 2005. Incidence by occupation and industry of acute work related respiratory diseases in the UK, 1992-2001. *Occupational and Environmental Medicine*, 62(12), pp. 836-842. Available at: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1740944&tool=pmcentrez&rendertype=abstract [Accessed 18 May 2017].

McDonald, J.C, Beck, M.H., Chen, Y., and Cherry, N.M., 2006. Incidence by occupation and industry of work-related skin diseases in the United Kingdom, 1996-2001. *Occupational Medicine*, 56(6), pp. 398-405.

Medicode (Firm), 1996. *ICD-9-CM: International classification of diseases, 9th revision, clinical modification*. Salt Lake City, Utah: Medicode.

Meyer, J.D.,Chen, Y., McDonald, J.C., and Cherry, N.M., 2002. Surveillance for work-related hearing loss in the UK: OSSA and OPRA 1997-2000. *Occupational Medicine*, 52(2), pp. 75-79

Moher, D., Liberati, A., Tetzlaff, J., Altman, D.G., and The PRISMA Group., 2009. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: the PRISMA Statement (Reprinted from Annals of Internal Medicine). *Physical Therapy*, 89(9), pp. 873-880. Available at: https://doi.org/10.1371/journal.pmed.1000097 [Accessed 18 May 2017].

Money, A., Carder, M., Hussey, L., and Agius, R.M., 2015. The utility of information collected by occupational disease surveillance systems. *Occupational Medicine*, 65(8), pp. 626-631.

Palmen, N.G.M., 2016. Early warning systems to detect new and emerging risks in Europe. National Institute for Public Health and the Environment. Ministry of Health, Welfare and Sport, Bilthoven, 2016. Available at: http://www.ifv.nl/kennisplein/Documents/20160501-RIVM-Early-warning-systems-to-detect-new-and-emerging-risks-in-europe.pdf [Accessed 18 May 2017].

Pascalicchio R, 2000. Classification of the causal agents of the occupational diseases (in all official European languages). European Occupational Diseases Statistics – EODS. Eurostat, Luxembourg.

Provencher, S., Labreche, F.P., and De Guire, L., 1997. Physician based surveillance system for occupational respiratory diseases: the experience of PROPULSE, Quebec, Canada. *Occupational and Environmental Medicine*, 54(4), pp. 272-276. Available at: http://oem.bmj.com/content/54/4/272.abstract?ijkey=aa9fc78d23146acf60c28a954fe4a99184aca222&keytype2=tf_ipsecsha [Accessed 18 May 2017].

Rappaport, S.M., 2011. Implications of the exposome for exposure science. *Journal of Exposure Science and Environmental Epidemiology*, 21(1), pp. 5-9. Available at: http://www.ncbi.nlm.nih.gov/pubmed/21081972 [Accessed 18 May 2017].

Rutstein, D.D., Mullan, R.J., Frazier, T.M., Halperin, W.E., Melius, J.M., and Sestito, J.P., 1983. Sentinel Health Events (occupational): a basis for physician recognition and public health surveillance. *American Journal of Public Health*, 73(9), pp. 1054-1062. Available at: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1651048&tool=pmcentrez&rendertype=abstract [Accessed 18 May 2017].

Samant, Y., Parker, D., Wergeland, E., and Wannag, A., 2008. The Norwegian Labour Inspectorate's Registry for Work-Related Diseases: data from 2006. *International Journal of Occupational and Environmental Health*, 14(4), pp. 272-279.

Siang, L.H., and Tan, A., 2010. Singapore's framework for reporting occupational accidents, injuries and diseases. *Asian-Pacific Newsletter on Occupational Health and Safety,* 17, pp. 28-31.

Spreeuwers, D., de Boer, A., Verbeek, J., van der Laan, G., Lenderink, A., Braam, I., van Beurden, M., and van Dijk, F., 2008. Time trends and blind spots: what employers, employees and policy-makers want to know about occupational diseases. *Policy and Practice in Health and Safety*, 6(1), pp. 65-78.

Spreeuwers, D., de Boer, A., Verbeek, J., and van Dijk, F., 2010. Evaluation of occupational disease surveillance in six EU countries. *Occupational Medicine*, 60(7), pp. 509-516.

Swedish Work Environment Authority, 2005. Occupational medical supervision. The Swedish Work Environment Authority's provisions on occupational medical supervision and general receommendations for applying the provisions. The Work Environment Authority´s Statute Book AFS 2005:6. Available at: https://liu.se/medfak/ike/internt/arbetsmiljo/laboratoriesakerhetshandboken/saker-arbetsmiljo-pa-labb/medicinska-kontroller-2/om-medicinska-kontroller/1.612519/OccupationalmedicalsupervisionAFS2005_6.pdf [Accessed 18 May 2017].

Takala, J., Hämäläinen, P., Saarela, K. L., Yoke Yun, L., Manickam, K., Wee Jin, T., Heng, P., Tjong, C., Guan Kheng, L.,, Lim, S. and Siok Lin, G., 2014. Global Estimates of the Burden of Injury and Illness at Work in 2012. *Journal of Occupational and Environmental Hygiene,* 11(5), pp. 326-337

Thacker, S.B., and Berkelman, R.L., 1998. Public Health Surveillance in the United States. *Epidemiologic Reviews*, 10, pp. 164-90. Available at: https://www.ncbi.nlm.nih.gov/pubmed/3066626 [Accessed 18 May 2017].

To, T., Tarlo, S.M., McLimont, S., Haines, T., Holness, D.L., Lougheed, M.D., Liss, G.M., and Cicutto, L., 2011. Feasibility of a provincial voluntary reporting system for work-related asthma in Ontario. *Canadian Respiratory Journal*, 18(5), pp.275-277.

Valenty, M., Homère, J., Lemaitre, A., Plaine, J., Ruhlman, M., Cohidon, C., and Imbernon, E,, 2015. Surveillance programme for uncompensated work-related diseases in France. *Occupational Medicine*, 65(8), pp.642-650. Available at: http://occmed.oxfordjournals.org/lookup/doi/10.1093/occmed/kqv104 [Accessed 18 May 2017].

Van der Laan, G., Spreeuwers, D., van der Molen, H., Pal, T., and Lenderink, A., 2009. Signals of new occupational health risks: an impetus for health and safety vigilance. Theme publication of Netherlands Center for Occupational Diseases. Amsterdam, Netherlands Center for Occupational Diseases, 2009.

Van Rooy, F.G.B.G.J., Rooyackers, J.M., Prokop, M., Houba, R., Smit, L.A., and Heederik, D.J., 2007. Bronchiolitis obliterans syndrome in chemical workers producing diacetyl for food flavorings. *American Journal of Respiratory and Critical Care Medicine*, 176(5), pp .498-504.

Waidyanatha, N., 2009. Towards a typology of integrated functional early warning systems. *International Journal of Critical Infrastructures*. Available at: http://www.inderscienceonline.com/doi/abs/10.1504/IJCIS.2010.029575?journalCode=ijcis [Accessed 18 May 2017].

Wu, T.N., Liou, S.H., Wang, J.D., Shen, C.Y., Ko, K.N., Yang, G.Y., Lai, J.S., Ho, C.K., Chao, S.L., Hsu, C.C., Guo, Y.L., Lai, M.S., and Chang, P.Y., 1996. Establishment of a work-related diseases surveillance system in Taiwan, Republic of China. *Preventive medicine*, 25(6), pp .725-729. Available at: http://www.ncbi.nlm.nih.gov/pubmed/8936575 [Accessed 18 May 2017].

# 13 List of abbreviations

| | |
|---|---|
| ADRs | adverse drug reactions |
| AFS | Arbetsmiljöverkets författningssamling; The Swedish Work Environment Authority's Statute Book |
| ANSES | The French Agency for Food, Environmental and Occupational Health and Safety |
| ASL | Local Health Department (Italy); Azienda Sanitaria Locale |
| BRFSS | Washington State Behavioral Risk Factor Surveillance System |
| CCPP | Occupational Diseases Consultation Centres (France) |
| CDC | Centers for Disease Control and Prevention |
| CDPR | California Department of Pesticide Regulation |
| CEPROSS | Occupational Diseases Registry of the Social Security System (Spain); Comunicación de Enfermedades Profesionales en la Seguridad Social |
| CODIS | Center for Occupational Disease and Injury Services |
| COEH | Centre of Occupational and Environmental Health (University of Manchester) |
| CSO | Central Statistics Office (Ireland) |
| DMP | departmental medical practitioner |
| DoL | Department of Labour (New Zealand) |
| ENM | engineered nanomaterials |
| ENT | ear, nose and throat |
| EpiNano | French Registry Of Workers Handling Engineered Nanomaterials |
| EU | European Union |
| EU-OSHA | European Agency for Safety and Health at Work |
| FIOH | Finnish Institute of Occupational Health |
| FOD | Fund Occupational Diseases (Belgium) |

| | |
|---|---|
| GAST | Occupational Health Warning Group (France); Groupe d'alerte en santé travail |
| HHE | Health Hazard Evaluation |
| IIAC | Industrial Injuries Advisory Council |
| IIDB | Industrial Injuries Disablement Benefit Scheme |
| ILO | International Labour Organization |
| INAIL | National Institute for Insurance against Accidents at Work |
| INSL | Institute of public health and labour of Navarre (Spain); Instituto Navarro de Salud Laboral |
| InVS | French Institute for Public Health Surveillance |
| ISPEL | National Institute for Occupational Health (Italy) |
| KOWAS | Korea Work-related Asthma Surveillance |
| LFS | Labour Force Survey |
| MALPROF | Professional diseases surveillance system (Italy); MALattie PROFessionali |
| MCP | Surveillance programme of work-related diseases (France); Les maladies à caractère professionnel |
| MH | Medical Subject Headings |
| Modernet | Monitoring Occupational Diseases and tracing New and Emerging Risks in a NETwork |
| MOSS | Musculoskeletal Occupational Surveillance Scheme for Rheumatologists |
| NCOD | Netherlands Center for Occupational Diseases |
| NIOH | National Institute of Occupational Health (Norway) |
| NIOSH | National Institute for Occupational Safety and Health (USA) |
| NODIS | Network of Occupational Disease and Injury Services (Taiwan) |
| NODS | Notifiable Occupational Disease System (New Zealand) |
| NSW | New South Wales |

| | |
|---|---|
| NWISP | National Work Injuries Statistics Program |
| NZ-OSH | Occupational Safety and Health Service New Zealand |
| OCCAM | OCcupational CAncer Monitoring |
| OccWatch | Occupational Diseases Sentinel Clinical Watch System |
| OD | occupational disease |
| ONAP2 | Programme for surveillance of professional asthma (France); Observatoire National des asthmes professionnels |
| OPRA | Occupational Physicians Reporting Activity |
| OSH | occupational safety and health |
| OSSA | Occupational Surveillance Scheme for Audiological physicians |
| OWRAS | Ontario Work-Related Asthma Surveillance |
| PANOTRASTSS | annex to the occupational diseases list to register non-traumatic health effects that may be considered ODs in the future, but are not today (Spain); Patologías no traumáticas causadas por el trabajo (accidentes de trabajo) de la Seguridad Socia |
| PCC | poison control centres |
| PI | prevention index |
| PIM | Surveillance project for intensive notification (Netherlands); Peilstation Intensief Melden |
| PIN | progressive inflammatory neuropathy |
| PISP | Pesticide Illness Surveillance Program |
| PMSI | Medical information system programme (France); Programme médicalisé du système d'information |
| PNMS | The French National Program for Mesothelioma Surveillance |
| PRESS-WORD | Program to Reduce Exposure by Surveillance System — Work-related diseases |
| PROPULSE | Physician-based Surveillance System For Occupational Respiratory Diseases |

| | |
|---|---|
| PRR | Proportional reporting ratios |
| QNHS | Quarterly National Household Survey |
| RAS | Registry of work-related diseases (Norway); Register for Arbeidsrelaterte Sykdommer |
| RIDDOR | Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (UK) |
| RNV3P | National occupational illness surveillance and prevention network (France); Réseau national de vigilance et de prévention des pathologies professionnelles |
| RR | relative risk |
| SABRE | Surveillance of Australian Workplace Based Respiratory Events |
| SAPS | South African Pulmonology Society |
| SASOHN | South African Society for Occupational Health Nurses |
| SASOM | South African Society for Occupational Medicine |
| SENSOR | Sentinel Event Notification System for Occupational Risks |
| SHARP | Safety & Health Assessment & Research for Prevention |
| SHE | sentinel health event |
| SIGNAAL | Signalling new occupational disorders (Belgium and the Netherlands); Signalering Nieuwe Arbeidsgerelateerde Aandoeningen Loket |
| SMEs | small and medium-sized enterprises |
| SORDSA | Surveillance of Occupational Respiratory Diseases in South Africa |
| SOSMI | Surveillance of Occupational Stress and Mental Illness |
| SUVA | Swiss National Insurance Fund |
| SWI | Self-reported Work-related Illness survey |
| SWORD | Surveillance of Work-related and Occupational Respiratory Disease |
| THOR | The Health and Occupation Research network |

| | |
|---|---|
| THOR-ENT | Occupational Surveillance of Otorhinolaryngological Disease |
| THOR-EPIDERM | Occupational skin surveillance |
| THOR-GP | The Health and Occupation Reporting Network for General Practitioners |
| THOR-SIDAW | Surveillance of Infectious Diseases At Work |
| TMS | Programme for the surveillance of musculoskeletal problems (France); Programme de surveillance des troubles musculo-squelettiques |
| WRDs | work-related diseases |

TE-RO-17-007-EN

**The European Agency for Safety and Health at Work (EU-OSHA)** contributes to making Europe a safer, healthier and more productive place to work. The Agency researches, develops, and distributes reliable, balanced, and impartial safety and health information and organises pan-European awareness raising campaigns. Set up by the European Union in 1994 and based in Bilbao, Spain, the Agency brings together representatives from the European Commission, Member State governments, employers' and workers' organisations, as well as leading experts in each of the EU Member States and beyond.

**European Agency for Safety and Health at Work**

Santiago de Compostela 12, 5th floor
48003 Bilbao, Spain
Tel. +34 944358400
Fax +34 944358401
E-mail: information@osha.europa.eu

**http://osha.europa.eu**

Publications Office