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Alert and sentinel approaches for the identification of work-related diseases in the EU

European Risk Observatory Report

European Agency for Safety and Health at Work

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Executive summary

Continuous changes in work and working conditions result in the rise of new occupational health (OH) risks and possibly new work-related diseases (WRDs). Monitoring these new health risks and WRDs is essential in order to better understand their work-relatedness and to ensure timely interventions and prevention. Detecting new work-related risks and diseases requires additional instruments to those already used for monitoring known occupational diseases (ODs). A comprehensive approach is required, one that uses several complementary methods which might be influenced by the type of disease and its prevalence in the (risk) population. 'Alert and sentinel systems' is an umbrella term for timely surveillance systems that collect information on diseases to initiate health interventions and prevention. These early warning systems aim to detect new combinations of health problems, exposure and work settings at an earlier stage to prevent work-related health problems. They therefore provide useful information to complement official figures of ODs. A comprehensive sentinel system can be looked upon as a chain of information and communication systems, made up of signal detection, work-relatedness evaluation, signal strengthening and timely alerting of stakeholders, which provides time to respond to and minimise the impact of the potential health threat.

This is the final report of the European Agency for Safety and Health at Work's (EU-OSHA's) project *Methodologies to identify work-related diseases: Review on sentinel and alert approaches.* The overall objective of this project was to describe several alert and sentinel types of approaches implemented in the EU (and outside it if relevant) to identify emerging work-related health problems and diseases, and support evidence-based prevention and policy-making. A further aim of the project was to formulate recommendations for setting up such alert and sentinel systems, building on an analysis of drivers of and obstacles to the systems studied in the project. The target groups are policy-makers at national and EU levels, including social partners, researchers, those involved in OD recognition and statistical data collection, and those who develop approaches for the health surveillance of workers.

This project aims to contribute to an 'improvement of the prevention of WRDs by tackling new/emerging risks', one of the major challenges identified in the EU Occupational Safety and Health (OSH) Strategic Framework 2014-2020 (European Commission, 2014). It also supports Recommendation 2003/670/EC2 concerning the European schedule of occupational diseases (European Commission, 2003) and calling on Member States to, among other things, introduce a system for the collection of information or data concerning the epidemiology of diseases of an occupational nature. By doing so, this project contributes to the implementation of Principle 10 of the European Pillar of Social Rights, namely 'Healthy, safe and well-adapted work environment and data protection' (European Commission, 2017).

Methodology

The project consisted of five main tasks:

- Task 1: desk research and production of a literature review report (EU-OSHA, 2017);
- Task 2: in-depth description of a selection of alert and sentinel approaches through interviews, qualitative analysis and in-depth desk research;
- Task 3: an expert seminar (18 May 2017, Brussels, Belgium) to discuss the outcomes of Tasks 1 and 2;
- Task 4: production of the present final report and a summary report (EU-OSHA, 2018);
- Task 5: a policy workshop (31 January 2018, Leuven, Belgium) to disseminate the project's findings to stakeholders.

The authors of the relevant references were also contacted to obtain missing information and to review the retrieved data. A total of 75 surveillance systems covering 26 different countries were identified. An algorithm was developed to divide these systems into different types that addressed the aspects of the population covered by the system (workers and/or the general population), the type of surveillance (active, passive or sentinel), the linkage to workers' compensation, whether the system monitored all

WRDs or only one or a subset of WRDs and, finally, whether or not the system was suitable or specifically designed for the detection and alerting of new/emerging work-related health problems. As a result, a typology was developed and 50 systems were retained for analysis and described in a literature review report (EU-OSHA, 2017). The typology and the list of 50 systems described in the literature review are summarised in Figure 1.

Drawing on the typology, a sample of 12 systems was selected for more detailed analysis (Task 2), in particular with regard to the practical aspects of the implementation of the systems and their link with prevention and policy-making. The systems are described in the final report (EU-OSHA, 2018). The criteria for the selection of these systems included: the types of WRDs covered; systems that have existed long enough to demonstrate how the data generated can be used in practice; particularly interesting systems or systems with innovative features; systems that cover issues not covered by other monitoring schemes; systems that are particularly useful for guiding and directing workplace prevention; to cover a diverse range of Member States; and systems that are aimed at detecting a diverse range of work-related health problems, exposures and sectors, relevant to both genders, with specific attention to small and medium-sized enterprises.

In-depth descriptions of six of the 12 systems were obtained through phone interviews with 19 stakeholders (including, for each system described, the owner of the system, the actor reporting to it and the researcher or other stakeholder using the resulting data) and qualitative analysis. Owing to resource limitations, the other six systems were studied through in-depth desk research.

The six systems described in depth through interviews with stakeholders were the following:

1. a compensation-related system with an 'open list' approach – Schweizerische Unfallversicherungsanstalt (SUVA) reporting system (Switzerland);
2. a non-compensation-based system for reporting all WRDs – Malattie Professionali (MALPROF) (Italy);
3. a non-compensation-based system including general as well as disease-specific schemes – The Health and Occupation Reporting Network (THOR) (United Kingdom);
4. a non-compensation-based system for all WRDs suitable for data mining – Réseau national de vigilance et de prévention des pathologies professionnelles (RNV3P) (France);
5. a sentinel system for all WRDs – Signalering Nieuwe Arbeidsgerelateerde Aandoeningen Loket (SIGNAAL) (Belgium and the Netherlands);
6. a sentinel system for a specific type of WRDs – Sentinel Event Notification System for Occupational Risks (SENSOR)-Pesticides (USA).

The six systems described though in-depth desk research were:

1. a non-compensation-based system for all WRDs suitable for sentinel surveillance – Register for Arbeidsrelaterte Sykdommer (RAS) (Norway);
2. a non-compensation-based system for all WRDs, the Occupational Health Surveillance Programme (OHSP) in Navarre – programa de Vigilancia Epidemiológica en Salud Laboral en Navarra (Spain);
3. a non-compensation-based system aimed at one type of exposure (nanoparticles) – EpiNano (France);
4. a sentinel system for unusual health events and WRDs, the Occupational Health Warning Groups - Groupe d'Alerte en Santé Travail (GAST) (France);
5. a sentinel system for WRDs related to chemical, biological and physical hazards, the National Institute for Occupational Safety and Health (NIOSH) Health Hazard Evaluations (HHEs) (USA);
6. a public health surveillance system including workers, the Labour Force Surveys (LFSs) in Ireland and United Kingdom.

Each system was described in an outline containing the following information: country information (for example information on population, employment rate), system history, initiating organisation, and aim and objectives of the system; target population, health problems targeted and types of exposure targeted; a detailed description of the workflow (reporting parties, reporting mechanisms, work-relatedness evaluation procedure, communication between experts, data storage), dissemination mechanisms and financial aspects; examples of use of data for prevention and detection of

new/emerging risks, and examples (in some cases) of collaboration with other parties across policy areas; strengths of the system (with an assessment of success factors and facilitators for implementation); drawbacks and limitations; and possible improvements. The findings were presented and consolidated at an expert workshop on 18 May 2017 with system owners and users, researchers and actors in the disease recognition area (Task 3).

Drivers and obstacles to the implementation of alert and sentinel approaches

The following key drivers and obstacles emerged from this work.

Visibility of the system: regardless of the quality of these systems, some are poorly described in the literature or not described in English. This lack of visibility may be an obstacle to the impact of these systems and to their sustainability. To raise awareness of these systems, their results can, for instance, be published and disseminated through reports or newsletters targeted at, for example, physicians. Another possible way of raising awareness is to provide open access to case reports stored in a database. In addition, success stories should be shared, especially in terms of the impact of the data gathered by these systems on the development of preventive actions and policies, supported by concrete examples. Sharing success stories not only raises awareness of a system but also demonstrates its added value, which would motivate reporting parties to report cases and other stakeholders to make resources available for the implementation of such systems.

Motivation of reporting parties: an important issue that emerged was the motivation of the reporting parties to report cases to the systems. Physicians are the main reporting parties to most of the systems described, and the main problem in engaging physicians and encouraging them to report was linked to the increasing work demands and time constraints in their daily clinical practice, which allow for very few additional activities. An essential step towards increasing physician reporting is the simplification of reporting procedures by, for instance, automating reporting or, as is happens in the Norwegian RAS and US HHE systems, making the reporting possible without burden of proof. Another possible way to motivate physicians to report is to provide different means of feedback so that reporting becomes a process of two-way communication and reporters see added value for them in reporting to the system. Incentives to report may include providing feedback to the reporters on the evaluation procedure, sending them reports, providing them with professional development opportunities through access to online training –such as the Electronic, Experiential Learning, Audit and Benchmarking (EELAB) web platform in the United Kingdom's THOR system – or financial incentives –as in the Norwegian RAS system. In Italy, by law healthcare providers have to report all suspected WRDs to the authorities, which encourages reporting.

Exposure assessment: an important obstacle related to the systems' implementation was the lack of adequate exposure assessments. Many interviewees emphasised the importance of this step in the data collection and work-relatedness evaluation procedures, especially in terms of identifying potential new/emerging WRDs. Several approaches are used, from including more extensive exposure descriptions in the reporting procedure to filling in the gaps after reporting when the exposure evaluations are carried out by experts or through workplace inspections (for instance SIGNAAL, MALPROF and SUVA). Some systems have developed tools to help with exposure assessment, for instance a specific thesaurus, providing hierarchical codes for all types of exposures (such as RNV3P and SENSOR-Pesticides), or a specific instrument developed for exposure assessment in workplaces, such as EpiNano for collecting data on exposure to nanoparticles.

Standardisation and quality control of the data collected: this is an important driver, as the quality of the data determines the quality of the work-relatedness evaluation. Among the systems described, there are several examples of how standardisation can be implemented in practice. They start with a clear definition of reportable cases and strictly defined criteria for defining a case as work related. Quality control exercises are carried out for some systems to improve the quality of coding (for example SENSOR-Pesticides) or, for some systems, the assessment of cases is discussed annually with reporting parties (for instance OHSP Navarra). It is also important that codes are regularly updated to follow current OSH trends.

Awareness and mechanisms for the detection of new/emerging WRDs: one of the main conditions for capturing new WRDs is that reporting parties are aware that new combinations of work-related health problems and risks may occur. Some systems ensure that this is the case by disseminating information on these to reporters, for example through publications and presentations at conferences and key events. The work-relatedness evaluations in the case of some systems specifically designed to detect new/emerging WRDs are performed by teams of experts in the field of new/emerging WRDs (for example SIGNAAL, RNV3P). Other systems specifically designed to investigate unusual health events at work (for instance GAST, HHE) are open to different reporting parties, have a low reporting threshold and employ multidisciplinary teams to investigate cases. One system (EpiNano) has a very specific scope and focuses on new and emerging health risks related to exposure to nanomaterials. It begins by identifying exposure in order to establish surveillance of potential eventual health problems, which is similar to an active surveillance approach. Other systems focus on identifying sectors and work tasks at risk (for example MALPROF), are suitable for data mining and identifying disproportionality signals in the existing database (such as RNV3P) or allow a proactive search for cases in response to alerts of new WRDs from other sources (for instance SUVA). On the other hand, systems linked to workers' compensation have a limited capacity to detect new/emerging WRDs. One important factor in the detection of new WRDs is the ability of WRD specialists to exchange, with colleagues abroad, suspicions of a new WRD, in order to facilitate the identification of similar cases. The pilot platform Occupational Diseases Sentinel Clinical Watch System (OccWatch) (in the test phase at the time of writing this report) aims to support such international collaboration and the sharing of data reporting by different national systems across Europe.

Link with prevention: collaboration between the actors of the systems and OSH public bodies is a key driver in ensuring a link between these systems and prevention. The data from systems that are not linked to compensation, and are designed to improve the collection and analysis of data to measure trends in OSH and WRDs, have a stronger link with prevention than data from other systems, as the former tend to have a strong connection with OSH public bodies, which in some cases are even the systems' owners, and are therefore used to design evidence-based prevention and guide policy-making. Two-way communication between system experts and workplace-level actors is also key to identifying risks, sectors at risk, incidences of OSH outcomes and trends. Defining different levels of alert based on the categorisation of signals is also recommended, as in the case of RNV3P, SIGNAAL and SENSOR-Pesticides. A level 1 alert typically triggers notification to an internal group of system experts and reporting parties and triggers secondary prevention in the workplace concerned. A level 2 alert results in dissemination to a larger group of experts and workplace-level actors to initiate actions in the sectors and workplaces at risk. A level 3 alert involves alerting the OSH (and possibly public health) authorities, to potentially trigger actions at a higher (regional or even national) level.

Political and financial support and resources: the issue of financial support seems to affect mainly the systems that are not related to compensation. Indeed, these systems rely mostly on government funding, which is often unstable and insufficient and depends on the level of priority that the government gives to OSH. The financial costs mainly include personnel costs and expenditures such as software maintenance (as all systems are web based) and the publication of periodic reports. Although the experts who maintain the systems are often powerless with regard to these financial issues, a good way to deal with this obstacle is to demonstrate the importance of the work performed by these systems. Therefore, it is necessary to produce and publish deliverables that not only highlight emerging OSH problems but also evaluate potential (new) solutions. This way, policy-makers may be more motivated as they may feel that the money given to the systems provides something in return. In addition, the business case must be made by sharing and disseminating success stories/best practices with concrete examples of how the data gathered by the systems have had successful impacts on prevention and policy development. Ultimately, political will was emphasised as a key driver of the implementation of alert and sentinel approaches, and this was considered to be influenced by the EU-level policy agenda. The importance of setting the identification of (new) WRDs as a priority at EU level over time was underlined.

Recommendations and conclusions

- There is no ideal surveillance system for new/emerging WRDs. Several different approaches have been described in this report and each has its strong points and disadvantages. When implementing sentinel approaches, stakeholders should take into account the occupational context in place and learn from good practice examples from other countries. In addition, they should aim to implement approaches complementary to those already in place.
- Some systems described in the report can generate 'individual sentinel signals', that is individual cases of potentially new WRDs or new correlations between exposure and WRDs. However, only a few systems are specifically designed to provide such signals. Real sentinel systems, such as SIGNAAL, GAST and HHE, are the only systems whose primarily purpose is to identify individual cases of potentially new WRDs or new exposure-WRD correlations. These systems follow the sentinel model and assess signals through several steps: cases reported by OH physicians or other experts, work-relatedness evaluation by a team of experts, strengthening of signal through further investigation and raising different levels of alert to trigger preventive actions.
- Alternative approaches to capturing individual sentinel signals are compensation-based systems with a sentinel aspect, that is with an 'open list' approach or a set of data independent from compensation, such as the SUVA system; non-compensation-related systems designed for data collection and statistics integrating a sentinel feature, such as the French RNV3P; or public health systems with a sentinel aspect such as systems that monitor the health of the general population and workers and have features of a sentinel system, such as the US Pesticide Illness Surveillance Program (PISP) in California (derived from the US SENSOR-Pesticides).
- Individual sentinel signals are mainly used to raise alerts and trigger preventive actions at the workplace level. However, if the signal is strengthened, they can also be used to alert occupational and public health authorities.
- Apart from individual sentinel signals, some systems can provide 'population-based sentinel signals', meaning that they can identify groups of workers at risk or economic sectors with an increased incidence of a WRD. Systems that are suitable for identifying these signals are non-compensation-related systems characterised by a wide coverage and a large database that can be used for statistics and data mining. Several good examples are described in the report, such as THOR, Occupational Cancer Monitoring (OCCAM, for work-related cancer) and RNV3P.
- Alternative approaches to identifying population-based signals are data mining in databases of compensation-based systems such as Safety & Health Assessment & Research for Prevention (SHARP) in Washington State, and survey-based public health systems such as the LFS, or occupational health surveillance and epidemiological studies (not in the scope of this project).
- Population-based signals are used mainly as an input for OH or public health authorities to support long-term policies and prevention plans, by identifying vulnerable groups of workers and emerging trends in WRDs. However, population-based signals can also be used to strengthen individual signals.
- The main gap in terms of monitoring specific groups of WRDs is the identification of multifactorial and/or long-latency WRDs such as mental diseases, musculoskeletal diseases or certain cancers. Improving the reporting of data on exposure assessments and the establishment of clearly defined assessment criteria for the evaluation of work-relatedness would help. With regard to economic sectors, the focus is still on the traditional sectors such as agriculture and construction, whereas important sectors such as the hotel, restaurant and catering sector (HORECA), or 'newer', growing sectors such as communication and IT services, are not or only poorly covered. There is also a lack of alert and sentinel systems that capture potential work-related health disorders related to new and emerging technologies such as those involving nanomaterials or advanced robotics.

- Two-way communication between stakeholders and the owners of/researchers involved in the systems is essential for the long-term maintenance of alert and sentinel systems and their effective link with prevention. Key stakeholders in terms of prevention are workplace-level actors (including employers and workers' representatives), OH organisations and services (such as labour inspectorates) and occupational (and public) health authorities.
- The development of EU-wide sentinel surveillance could contribute to the improvement of sentinel surveillance in the EU at several levels, especially in terms of harmonising reported data across different EU countries, better identification and prevention of WRDs, complementing official figures of ODs, developing evidence-based policy and assessing the burden of WRDs in the EU. To achieve this, efforts need to be made to improve the alert and sentinel function of the existing systems in place, and possibly implement new systems based on good practices. Further necessary steps are the harmonisation of the data collected by these systems and the establishment of an international network for exchanging data and knowledge regarding new WRDs.
- The importance of international collaboration between different countries and systems was highlighted throughout this project. International initiatives such as the Monitoring Occupational Diseases and tracing New and Emerging Risks in a NETwork (Modernet) and the OccWatch platform are good starting points and, during this project, various experts expressed their interest in taking part in OccWatch.
- This project has generated insights into various alert and sentinel approaches for the detection and prevention of WRDs and has encouraged the exchange of information and good practices. The workshops held as part of the project contributed to the exchange of experiences and the sharing of success stories, which help actors in countries where there is no alert and sentinel systems to make the case for such approaches. We hope that the final report will serve as a useful tool and an inspiration to implement some of these approaches in other countries. The workshops also fostered cooperation in the EU and gave rise to concrete opportunities for collaboration between participants, for example on a thesaurus for the coding of exposure data and through the OccWatch platform. As a follow-up to this project, EU-OSHA will continue to support networking and the dissemination of information on alert and sentinel approaches and new WRDs on its website and through a series of national-level dissemination workshops.

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 on society, which in turn leads to the loss of productivity and increased demands for medical services. The best estimate of global work-related deaths is approximately 2.3 million per year, with work-related diseases (WRDs) (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 entirely or partly caused by work-related factors, remains difficult. Criteria for the notification and recognition of occupational diseases (ODs) significantly differ in EU countries, in both the legal and social security contexts, thus making figures on ODs and WRDs unreliable and limiting their utility for monitoring existing ODs in EU countries, or for identifying newly occurring ODs (Spreeuwers et al., 2010). A recent review on OD registries in several different countries shows that most of these registries do not provide a comprehensive approach and are incomparable because there are no international agreements and standards (Davoodi, 2017).

Moreover, continuous changes in work and working conditions result in the rise of new occupational health (OH) risks and possibly new 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 and 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 OH risks. Where there is insufficient knowledge of these risks, opportunities for intervention and prevention may be missed (Harremoës et al., 2001). One of the main conclusions of the European Environment Agency report *Late Lessons from Early Warnings* (European Environment Agency, 2013) was that there is a lack of institutional and other mechanisms to respond to early warning signals, which may lead to the transfer of the costs to society. One of their main recommendations was to reduce the delay between early warnings and preventive actions.

These concerns were already reflected in the priorities identified in the EU strategy 2007-2012 on health and safety at work (European Commission, 2007) and were expressed in the European Parliament resolution on the mid-term review of this strategy (European Parliament, 2011). In addition, the EU Occupational Safety and Health (OSH) Strategic Framework 2014-2020 (European Commission, 2014), points out ‘improvement of the prevention of WRDs by tackling new/emerging risks without neglecting existing risks’ as one of the major challenges in OSH. These successive European strategies on health and safety at work have led to the setting up of a European Risk Observatory, established by the European Agency for Safety and Health at Work (EU-OSHA) in order to carry out tasks identified in the European strategies. Therefore, the main objective of EU-OSHA’s European Risk Observatory is to take on a range of activities to identify and anticipate new and emerging risks in OSH and ensure their timely prevention.

The lack of timely identification and prevention of new work-related hazards may introduce new WRDs or ODs. Recommendation 2003/670/EC2 concerning the European schedule of occupational diseases (European Commission, 2003) does not explicitly focus on new work-related illnesses or ODs, 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 diseases listed in Annex II of the schedule 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.

Alert and sentinel systems allow the detection of work-related diseases and therefore provide useful information to complement official figures of ODs well as to support timely evidence-based prevention, thus contributing to the implementation of the European Pillar of Social Rights, in particular Chapter II, 'Fair working conditions', Principle 10, 'Healthy, safe and well-adapted work environment and data protection', according to which 'Workers have the right to a high level of protection of their health and safety at work' (European Commission, 2017).

1.2 Definitions and typology of new work-related diseases

A 'new occupational safety and health risk' has been defined by EU-OSHA (EU-OSHA, 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 long-standing issue that is newly considered a risk as a result of a change in social or public perceptions; or
- is a long-standing issue that new scientific knowledge allows to be identified as a risk.

New WRDs can be categorised in various ways. Some examples are given in Table 1. 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, such as popcorn disease and progressive inflammatory neuropathy. In other cases, new data allowed new cause and effect links to be made 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 1: Categories and examples of new work-related diseases

Category	Diseases	Causes
New diseases due to changes in work and working conditions	Progressive inflammatory neuropathy	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
New knowledge about diseases caused by known forms of exposure	Breast cancer	Long-term night-shift work
	Cardiovascular diseases	Exposure to ultra-fine particles

Category	Diseases	Causes
	Lung infections	Exposure to welding fumes
Newly recognised consequences of occupational exposure of offspring through 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' ODs or WRDs. 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 OH risks, such as data mining in existing databases (Bonneterre, Bicout & de Gaudemaris, 2012) or spontaneous reporting of new OH 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 (in other words, 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 (in other words, 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). Another method to investigate emerging risks is to perform health surveillance among exposed workers. In this way, the primary focus is not on the health effect, but on the exposure. Health surveillance can be used as an early warning system for the unknown effects of exposures, for example exposure to nanoparticles (Palmen et al., 2013).

'Alert and sentinel 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 (in other words detection of early health effects, which is a specific form of health surveillance). Alert and sentinel systems aim to detect new combinations of health problems, exposure and work settings at an early stage to prevent work-related health problems. A comprehensive alert and sentinel system can be looked upon as a chain of information and communication systems, made up of sensors (tools to capture 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, 2010).

Several health fields already benefit from these types of surveillance systems, for example the EU Early Warning and Response System (EWRS) for infectious diseases (Guglielmetti 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 underlined 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 & 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 Project structure and purpose of this report

The current report is the final report of the EU-OSHA's project *'*Methodologies to identify work-related diseases: Review on sentinel and alert approaches*'*. The overall objective of this project was to describe several approaches that have been taken to try to 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 WRDs and risk factors. It is mainly intended for policy-makers at the national and EU levels, including social partners, researchers, those involved in OD recognition and statistical data, and those who develop approaches for health surveillance of workers. It sought to provide these actors with recommendations for setting up systems that can support the development of their area of action.

The project consisted of five main tasks:

- Task 1: desk research and the production of a literature review (EU-OSHA, 2017);
- Task 2: in-depth description of a selection of alert and sentinel approaches through interviews, qualitative analysis and in-depth desk research;
- Task 3: an expert seminar (18 May 2017, Brussels, Belgium) to discuss the outcomes of Tasks 1 and 2;
- Task 4: production of the present final report and a summary report (EU-OSHA, 2018);
- Task 5: a policy workshop (31 January 2018, Leuven, Belgium) to disseminate the project's findings to stakeholders.

The present report provides an overview of different approaches that can be used to monitor new WRDs and a description of examples of systems that represent each different approach and feature important aspects for the detection and prevention of new and emerging WRDs. It is important to note that OH surveillance and epidemiological studies are not described in this report. Although they could be used to generate signals of new and emerging WRDs, those approaches are out of the scope of this project, as they use the 'exposure-first' method – meaning that they aim to detect exposures and, from there, investigate potential health effects on workers – whereas the systems described in the present report use the 'disease-first' method, starting by identifying the health effect and then going on to investigate potential exposures. Even though not described in this report, both OH surveillance and epidemiological studies are significant sources of signals and are complementary to the systems analysed in this report.

The report also discusses the drivers and obstacles of the systems described, and how data gathered by these systems are used in practice (for identification of risks, exposed groups, sectors and occupations, for prevention, for reporting, for monitoring and for priority setting in research). Finally, the present report seeks to clarify the added value of alert and sentinel approaches and provide evidence-based recommendations for the set-up of such approaches.

2 Methodology

2.1 Literature review

In the first phase of the project (Task 1), a systematic literature review was conducted in order to identify systems for detecting new/emerging WRDs and develop their basic typology. The literature review included searches of both scientific and grey literature. For the scientific literature search, a search strategy was developed combining the following three concepts: surveillance/reporting system; occupational/work-related diseases; and new/emerging risks. Several scientific databases were searched, and the search strategy was adapted to each of them. Furthermore, the snowballing technique was used to retrieve additional references from the bibliographies of the most cited relevant articles and documents. In order to identify relevant grey literature sources, well-known databases of grey literature regarding OSH were checked. In addition, data from the existing surveys held among OD experts in Europe in the period prior to the start-up of the literature review were used: the 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 the gathering of data on relevant related aspects' (European Commission, 2013a); a survey on OD monitoring systems among participants in Monitoring Occupational Diseases and tracing New and Emerging Risks in a NETwork (Modernet) (2011-2012); and 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 and so on), carried out by the Dutch National Institute for Public Health and the Environment, RIVM Bureau Reach, in preparation for the international conference on how to prevent work-related cancer in the EU, organised by the Dutch Ministry of Social Affairs and Employment in May 2016 (Palmen, 2016). Finally, relevant EU and research institute websites were searched to retrieve additional grey literature sources. A more detailed description of the methodology applied in the literature review, including the flow of information through the different phases of the review process, number of included/excluded articles, the search string and data extraction matrix, is available in the report on the literature review, published on the EU-OSHA website (EU-OSHA, 2017). Regarding data extracted for each identified system, the first aim was to retrieve some technical data to understand how data flow takes place in each system and who are the main actors involved in its maintenance (who reports cases, what is the reporting mechanism, which institution maintains the system, which types of diseases can be reported, which data are collected while reporting and so on). Moreover, the second aim was to learn more about the features that allow these systems to identify new/emerging WRDs (exposure assessment, evaluation of work-relatedness) and to provide a basis for preventive actions and recommendations for stakeholders.

2.2 Typology of the identified systems

In the literature review, 75 monitoring systems were identified, including systems implemented in EU Member States, but also in countries outside the EU. A list of all identified systems can be found in Appendix A of this report. Subsequently an algorithm was developed to categorise these systems into different types, addressing the questions in Table 2.

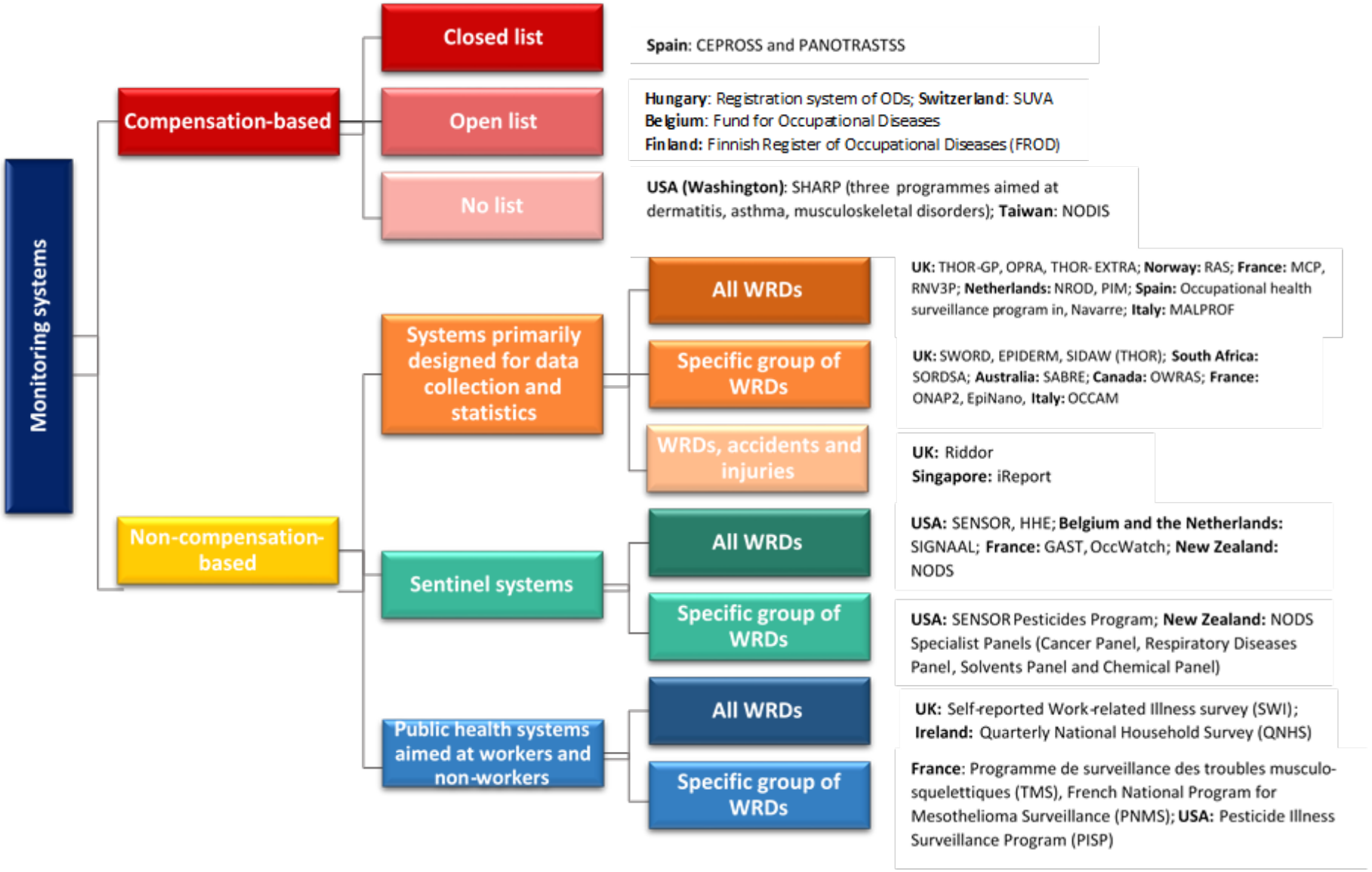
Table 2: Algorithm for classification of systems

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? If yes, what type of system?	Yes/no 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 aim to alert of new/emerging work-related health problems?	Yes/no

By using the given algorithm, a basic typology of these systems was set up by dividing them into four main groups: compensation-based systems, non-compensation-related systems primarily designed for data collection and statistics, sentinel systems, and public health surveillance systems covering workers and non-workers. These systems further differed in types of WRD monitored, coverage, data collection, mechanism of investigation of work-relatedness, follow-up of new/emerging risks, link with prevention and so on. Even though systems categorised as 'sentinel systems' are specifically designed with an alert and sentinel approach and mostly focus on new/emerging WRDs specifically, systems categorised in other groups also display some alert and sentinel aspects that allow them to identify new/emerging WRDs and provide the link with prevention. Therefore, each of the four groups will be further described in the following sections of the report, focusing on characteristics and aspects significant for detection and prevention of new work-related health risks and diseases.

In addition, the level of data retrieved from the literature was not the same for all the systems. Some of the systems were thoroughly described in the corresponding available references, whereas for others there was only the basic information. Bearing in mind the large number of systems identified and the paucity of information available for several of them, the list of systems to be described in the literature review was reduced to 50. When making this selection, the aim was to include systems that are interesting from the aspect of monitoring new/emerging WRDs, systems with enough available information and those that are the most recent active version, in cases where a system has been replaced with a new version. The typology and the list of the 50 systems described in the literature review are summarised in Figure 1

Figure 1: Typology of systems described in the literature review report (EU-OSHA-2017)



2.3 In-depth descriptions of a selection of systems

2.3.1 Selection of systems

Based on the findings from the literature review and on the typology developed, a sample of 12 systems was selected to be described in more detail, in particular with regard to the practical aspects of the implementation of the systems and their link with prevention and policy-making. The selection of the systems was made taking into account the range of countries and approaches identified in the literature. The criteria for the selection of these systems included types of WRDs covered; having existed long enough to show how data can be used in practice; particularly interesting systems or those with innovative features; coverage of issues not covered in other monitoring schemes; usefulness for guiding and directing workplace prevention; diversity across EU Member States; diversity in work-related health problems, exposures and sectors specifically targeted; relevance to both genders; and specific attention to small and medium-sized enterprises (SMEs). Six of the twelve systems were described though in-depth interviews with stakeholders and qualitative analysis and, because of resource limitations, the other six systems were the subject of in-depth desk research (see section 3).

The six systems described through in-depth interviews with stakeholders were the following:

1. a compensation-related system with an 'open list' approach – Schweizerische Unfallversicherungsanstalt (SUVA) reporting system (Switzerland);
2. a non-compensation-based system for reporting all work-related diseases – Malattie Professionali (MALPROF) (Italy);
3. a non-compensation-based system including general as well as disease-specific schemes – The Health and Occupation Reporting Network (THOR) (United Kingdom);
4. a non-compensation-based system for all work-related diseases suitable for data mining – Réseau national de vigilance et de prévention des pathologies professionnelles (RNV3P) (France);
5. a sentinel system for all work-related diseases – Signalering Nieuwe Arbeidsgerelateerde Aandoeningen Loket (SIGNAAL) (Belgium and Netherlands);
6. a sentinel system for a specific type of work-related diseases – Sentinel Event Notification System for Occupational Risks (SENSOR)-Pesticides (USA).

The systems described though in-depth desk research were:

1. a non-compensation-based system for all WRDs suitable for sentinel surveillance – Register for Arbeidsrelaterte Sykdommer (RAS) (Norway);
2. a non-compensation-based system for all WRDs, the Occupational Health Surveillance Programme in Navarre – programa de Vigilancia Epidemiológica en Salud Laboral en Navarra (Spain);
3. a non-compensation-based system aimed at one type of exposure (nanoparticles) – EpiNano (France);
4. a sentinel system for unusual health events and WRDs, the Occupational Health Warning Groups - Groupe d'Alerte en Santé Travail (GAST) (France);
5. a sentinel system for WRDs related to chemical, biological and physical hazards, the National Institute for Occupational Safety and Health (NIOSH) Health Hazard Evaluations (HHEs) (USA);
6. a public health surveillance system including workers, the Labour Force Surveys (LFSs) in Ireland and United Kingdom.

2.3.2 In-depth desk research and interviews with stakeholders

- **Methodology for the in-depth system description through interviews**

Development of interview protocol

The protocol for the qualitative research by means of semi-structured interviews was developed in a participatory fashion, involving the project team and researchers on the project. The interviews were set up in a semi-structured way, to allow for focused, conversational, two-way communication. Relevant topics were identified at the beginning of interview planning, mainly based on the results of Task 1, the literature review. A topic list (see Appendix C) was developed of all the topics that should be addressed during the interviews, with guiding questions for each topic (and possible suggestions for follow-on questions). The topics and guiding questions were adapted to the group of stakeholders interviewed.

Selection of interviewees and interview procedure

The project team selected three interviewees for each system, covering three different stakeholder groups:

- owner of the sentinel or alert system;
- workplace actor who reports to the system or uses it (such as OH physician, OH specialist, worker);
- researcher or other stakeholder using the system in monitoring, OD recognition, workplace prevention or reporting.

The list of all interviewees is given in Appendix C.

All interviews were conducted between October and December 2016. The data from the interviews were transcribed verbatim, and translated if necessary, by a specialised transcription bureau. Each system researched was described on the basis of the combined information from the interviews with the three interviewees. If necessary, additional information was also gathered through desk research.

Data description: presenting the systems in a structured way

The systems were described in an outline developed from the topic list containing country information (for example information on population and employment rate); system history, initiating organisation, and aim and objectives of the system; target population, targeted health problems, targeted types of exposure; a more detailed description of the workflow (reporting parties, reporting mechanisms, work-relatedness evaluation procedure, communication between experts, data storage), dissemination mechanisms, financial aspects; examples of use of data for detection and prevention of new/emerging risks and, in some cases, examples of collaboration with other parties across policy areas; strengths of the system, with an assessment of success factors and facilitators for implementation; drawbacks and limitations; and possible improvements. The system descriptions are presented in section 3. They are complemented with anonymous quotes from the interviews and concrete case examples.

- **In-depth desk research methodology**

For the six systems described in more depth through desk research only, an extensive search for information describing the development, functioning and results of the systems was performed, focusing more particularly on websites, grey literature (reports, presentations, non-scientific articles) and scientific publications, mainly found through searching the internet and snowballing the articles within the Task 1 literature review.

An outline was drawn up so that the reporting for these six systems would be as similar as possible to that of such systems described through interviews (see above). Compared with the interviews, limited information could be found on how the data gathered by the systems were used in terms of prevention and detection new/emerging risks; success factors for and obstacles to implementation; possible improvements; and collaboration with other policy areas,

After the information gathered was structured in accordance with the outline, a draft system description was presented to an expert who was familiar with the system, if one was available. Information from these reviewers was incorporated into the system description if applicable.

2.4 Expert workshop

The expert workshop was held in Brussels on 18 May 2017 and aimed to consolidate the findings of Task 1, the literature review (EU-OSHA, 2017), and the in-depth description of systems carried out as part of Task 2. The workshop brought together systems' owners and users, researchers and actors in the disease recognition area. The objective was to gain more insight into the drivers of and obstacles to the implementation of alert and sentinel systems. The workshop consisted of a morning session, including presentation of findings derived from the literature review and in-depth descriptions of the systems. In the afternoon session, participants had the opportunity to discuss in small groups the drivers of and obstacles to alert and sentinel approaches, important aspects for ensuring that they performed their alert function and good links with preventive actions. The group discussions followed the interactive World Café methodology. The workshop also allowed the researchers to learn about additional approaches that were not captured in the literature review (see section 2.6). The main discussion points and conclusions of the workshop were integrated as relevant into section 4 of this report, thus consolidating the findings from the Task 2 in-depth analysis on the drivers, obstacles and recommendations for improvement. The workshop summary report, the agenda and the participant list are available on EU-OSHA's website:

https://osha.europa.eu/en/tools-and-publications/seminars/methodologies-identify-work-related-diseases-review-sentinel-and.

2.5 Policy workshop

A second workshop was held in Leuven on 31 January 2018, and brought together leading experts and policy-makers from various countries to discuss and consolidate the results of the project. The participants included those nominated by the Agency's national focal points, mainly representatives of ministries of health, ministries of labour, national insurance bodies, national institutes of public health, other occupational and public health authorities, and EU policy-makers. In the morning session, the research team presented the findings of EU-OSHA's alert and sentinel systems review. The morning session also included presentations by and discussion with experts involved in three such systems: the United Kingdom's THOR, the French RNV3P and the Norwegian RAS. It was again an opportunity to obtain information on additional systems not captured in the literature review (see section 2.6).

The afternoon was dedicated to group work to discuss feasibility, added value, prerequisites and recommendations in relation to the implementation of alert and sentinel approaches. The workshop provided the opportunity to discuss the feasibility of implementing alert and sentinel approaches taking into account the various national contexts in the EU. Making use of the alert and sentinel approaches already in place in some EU countries to improve sentinel surveillance at both Member State and EU level and the importance of cooperating and exchanging data within the EU were highlighted. Opportunities for collaboration among participants were also identified. The main discussions and conclusions of the workshop were integrated into this report, mainly in the recommendations formulated in section 4.2 and in the conclusions in section 5. The workshop summary report is available on EU-OSHA's website at: https://osha.europa.eu/en/tools-and-publications/seminars/alert-and-sentinel-systems-identification-work-related-diseases-eu-0.

2.6 Examples of approaches not included in the literature review

The discussions that took place at the workshops as well the consultation of EU-OSHA's network of focal points allowed the researchers to learn about additional approaches that were not captured in the literature review. These approaches were not captured in the literature review either because they were not described in the published scientific literature at the time when the research team carried out the literature review or because they did not fit the definition of alert and sentinel systems or the inclusion/exclusion criteria defined in the search strategy. However, they are still relevant approaches to the identification of WRDs.

For example, the experts from the French national public health agency (Santé publique France) mentioned that in 2010 their agency implemented cohorts for epidemiological surveillance of workers

(Cohortes pour la surveillance épidémiologique en lien avec le travail, Coset) with the purpose of better describing and monitoring the links between occupational factors and the occurrence of health problems (muscular and joint problems, mental health problems, cardiovascular and respiratory problems, cancer and so on). This programme aims to identify risky occupations and working conditions, quantify occupational factors causing adverse health effects and propose recommendations for prevention. Both exposure and health effects are assessed by means of questionnaires given to the participating groups of workers (a representative group of all workers, or specific groups of workers such as agricultural workers) with the possibility of complementing these data with the national health insurance database.

Experts from the German Bundesanstalt für Arbeitsschutz und Arbeitsmedizin (BAuA) also provided information on existing approaches useful to tackle WRDs, including new risks, in Germany:

- In Germany, statistics about health in different jobs and branches are included in the annual statistics of health insurance companies: Allgemeine Ortskrankenkasse (AOK), Betriebskrankenkasse(BKK)-Bundesverband, DAKGesundheit and so on. BAuA uses these data to analyse the occurrence of sick leave in single occupations. The data are regularly included in BAuA's report on health at work, Sicherheit und Gesundheit bei der Arbeit, SuGA).
- The Robert Koch-Institut regularly runs different large cross-sectional and follow-up studies to analyse health in the German population. These studies include occupational health aspects.
- BAuA regularly runs large cross-sectional studies (BIBB [Bundesinstitut für Berufsbildung]-BAuA-Survey, Arbeitszeitmonitoring) to monitor occupational exposures and related health outcomes (complaints). Among other ongoing studies, for example, the follow-up study 'Studie zur Mentalen Gesundheit bei der Arbeit (S-MGA)"' considers mental health and work.
- The German National Cohort (GNC), a joint interdisciplinary endeavour, is implemented by a national network of 25 German research institutions. Its overall aim is to investigate the causes underlying major chronic diseases such as cardiovascular diseases, cancer, diabetes, neurodegenerative/psychiatric diseases, and respiratory and infectious diseases, and their pre-clinical stages or functional health impairments. Some occupational aspects are also considered in this study.
- Other ongoing epidemiological studies in Germany (for example the Gutenberg Health-Study) are used to analyse associations between occupational exposures (psychosocial aspects, shift work) and cardio-metabolic outcomes.
- As part of the annual statistics about notification, recognition and compensation of occupational diseases provided by the German Statutory Accident Insurance (DGUV), the Hautarzt-Verfahren (dermatologist procedure) is an approach to detect, report and treat very early dermal work-related disease (eczema, skin cancers), whereas the Psychotherapeuten-Verfahren (psychotherapist procedure) is implemented to provide early psychotherapeutic measures after (occupational) accidents to avoid mental health problems. Yet other approaches are used for early (occupational) rehabilitation (of musculoskeletal problems, for example).

Last but not least, the Spanish delegates shared information on Spanish regional alert and sentinel systems (García Gómez et al., 2017), of which the following ones were later added to section 3.2, 'Non-compensation-related systems for data collection and statistics' (with more detailed information in Appendix D):

- the Communication System for Suspected Occupational Diseases – Comunicación de Sospecha de Enfermedad Profesional (CSEP), launched in the Autonomous Community of the Basque Country;
- the Health Information and Epidemiological Surveillance System in Occupational Health – Sistema de Información Sanitaria y Vigilancia Epidemiológica Laboral (SISVEL), developed in Valencia; and
- the Evaluation of Suspected work-related Cancer – Equipo de Valoración de Sospecha de Cáncer Profesional del Principado de Asturias (EVASCAP), implemented in Asturias.

3 Results

The description of the 12 systems contained in this section builds upon the findings from the Task 1 literature review, the Task 2 in-depth analysis of systems and the expert workshop. For the sake of clarity and logical flow of information, this section is divided into four sub-sections corresponding to the four types of systems identified using the typology algorithm developed as part of this project: compensation-based systems, non-compensation-based systems for data collection and statistics, sentinel systems and public health systems. Each sub-section provides a general description and the main characteristics of that particular type of system. This is followed by an in-depth description of one or more concrete examples of systems.

3.1 Compensation-based national systems

A list of nine representative compensation-based national systems described in the Task 1 literature review (EU-OSHA, 2017) and their main characteristics are presented in Table 3. The main common feature of these systems is that they were designed to collect data for compensation purposes. Therefore, these systems are closely linked to the national insurance system of the country where they are implemented. Compensation-based systems are usually nationwide and exist in the majority of European countries. They are maintained by the national insurance fund or, less frequently, by the national institute for ODs.

Data flow in these systems is initiated once a case is reported for compensation purposes. Cases are mainly reported by the physicians who examined the employee, with some systems also allowing employees themselves, employers or trade union delegates to make a claim. The whole reporting process is insurance-driven and legally required for most of the national compensation-based systems in the EU. During the reporting procedure, the reporting party is obliged to provide information about the worker, the disease, the suspected exposure and causal relationship with work. In most of the systems, exposure data are described by the reporting party and additionally verified by specialists. In all systems, the work-relatedness of the cases is evaluated by the recognised authority (such as medical doctors from insurance bodies or OH physicians).

Based on the analysis of this type of system, performed as part of this project, it was concluded that some systems from this group can capture new WRDs, under certain conditions, although in the expert workshop many stakeholders saw the link with insurance as an obstacle to the detection of new WRDs.

The first condition is related to **the existence of an 'open list' of reportable WRDs or ODs**. Systems with a 'closed-list' approach allow the reporting of ODs only from a predefined list, which in return inhibits identification of new/emerging WRDs. The compensation-based systems that have an 'open list' approach also allow reporting of and compensation for diseases outside the prescribed list, as long as there is a certain level of proof regarding causal relationship with work. Examples of such systems are the national compensation systems in Belgium, Spain, Hungary, Finland and Switzerland. In the Spanish systems, there are two separate datasets. Following the Commission Recommendation concerning the European schedule of occupational diseases (2003/670/EC) (European Commission, 2003), the Spanish General Directorate of Social Security updated the occupational diseases list and notification procedure in 2006, and the dataset following this procedure is known as Comunicación de Enfermedades Profesionales en la Seguridad Social (CEPROSS). In addition, the legislation about ODs also establishes future mechanisms for the healthcare systems to communicate about dubious and suspect illnesses that could be considered ODs. Because the Spanish national health system is divided into 17 different regional systems with the capacity and authority to legislate on health issues on their own, the coordination role performed by the Ministry of Health and active collaboration between regions are essential to reach the target of communication about suspected ODs. On the other hand, the Spanish legal definition of accidents at work (AWs) covers any acute injury that the worker suffers as a result of performing the work. However, the legal definition of AWs also includes any illnesses that an

employee acquires that are not contained in the national ODs list but are closely linked, in terms of development or aggravation, with the work carried out. Therefore, in 2010 the General Directorate of Social Security created a new information source called Patologías no traumáticas causadas por el trabajo (accidentes de trabajo) de la Seguridad Social (PANOTRATSS) in order to study the diseases classified as AWs. These are not ODs, but are also considered for compensation in the same way as AWs. Finally, some systems, such as the one in Taiwan called the Network of Occupational Disease and Injury Services (NODIS) do not have any list of reportable diseases, but allow the reporting of any condition, as long as criteria on work-relatedness are met. The 'open list' approach and the absence of any reporting list are more suitable approaches for the identification of new WRDs than using a closed, predefined list.

The second condition for an alert component in compensation-based systems is a certain degree of **independence from compensation in terms of reporting**. This can be illustrated by the examples of the Swiss and Taiwanese systems. They pair a dataset of compensated cases (SUVA and the National Labour Insurance scheme in Taiwan) with an additional system (the Swiss Statutory Health Surveillance for Occupational Diseases and NODIS) that collects data unrelated to compensation, but which may also initiate compensation of the cases identified if appropriate. The objective of these additional systems is mainly the prevention and identification of new WRDs, in addition to compensation.

Compensation-based systems are also linked to **workplace preventive actions**, to a certain extent. Once again, the strength of these systems in terms of prevention is the ability to implement preventive actions regardless of the compensation aspect. For instance, the detection of an increased incidence of stress at work and burnout or musculoskeletal disorders in the Swiss system has led to the implementation of screening in companies and to organisational changes aimed at the reduction and prevention of these risks, even though these WRDs are seldom accepted for compensation because of their multifactorial nature. 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.

Another system with an interesting approach towards prevention is the one implemented in Washington State (USA), called the **Washington Safety & Health Assessment & Research for Prevention (SHARP) programme**. This system is uniquely related to compensation in the sense that it derives all its information through data mining in the Washington workers' compensation claims. It also has three separate schemes covering specific groups of WRDs: asthma, dermatitis and musculoskeletal disorders. As the main objective of this system is to identify high-risk occupations and industries and to design useful prevention strategies, case data are analysed periodically for clusters by industry and occupation, to help develop and prioritise specific prevention strategies and recommendations. 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 identify 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 & Liberty Mutual Research Institute for Safety, 2009).

In the following section, an in-depth description of the Swiss compensation-based system **SUVA** is provided as an example of a compensation-based system with features that allow monitoring new/emerging work-related risks and diseases.

Table 3. Main characteristics of compensation-based systems described in Task 1 literature review (EU-OSHA, 2017)

Country (start date)	System	Organisation maintaining the system	Methods of data collection	Exposure assessment	Work-relatedness evaluation	Follow-up of new/emerging risks (yes/no); usage of data for dissemination/prevention
Spain (CEPROSS 2006; PANOTRATSS 2010)	CEPROSS database (ODs official schedule) PANOTRATSS database (illnesses related to work classified as accidents at work)	General Directorate of Social Security	Obligatory reporting for employers and insurance companies	Described by reporting physician	CEPROSS system: 'iuris et de iure' criteria PANOTRATSS system: the relationship must be proven	Yes; dissemination through reports, labour inspections
Switzerland (1984)	Statutory health surveillance organised by SUVA	SUVA	Reporting by physicians	Additional verification by specialists reporting/assessing the claim	Medical doctors of the insurance funds	Yes; dissemination through reports
Hungary (1996)	Mandatory reporting and registration system of ODs	Office of the Chief Medical Officer (Department of Occupational Health)	Obligatory reporting by physicians	Described by reporting physician and checked by the Hungarian OSH inspection authority	Medical doctors and work hygiene specialists of the Office of the Chief Medical Officer	Yes; annual report to the government, summary reports in scientific journals, possible link with prevention, depending on policy-makers' and stakeholders' interest
Finland (1964)	Finnish Register of Occupational diseases (FROD)	Finnish Institute of Occupational Health	Obligatory reporting by physicians	Described by the reporting physician	Experts from the Finnish Institute of Occupational Health, team of experts in the Ministry of Social Affairs and Health	No; publication of alert information
Belgium (2000)	Fund Occupational Diseases (FOD)	FOD	Obligatory reporting by physicians, employees	Additional verification in cases when further health surveillance is indicated	Medical doctors from the insurance funds; possible consultation with expert commission on new ODs	No; no further usage of data

Country (start date)	System	Organisation maintaining the system	Methods of data collection	Exposure assessment	Work-relatedness evaluation	Follow-up of new/emerging risks (yes/no); usage of data for dissemination/prevention
Taiwan (2007)	NODIS	Center for Occupational Disease and Injuries Services (CODIS)	Voluntary reporting by OH physicians	Described by reporting party based on careful details of working conditions, photographs of workplace and site inspection (in one out of four cases)	Three senior OPs, using the same work-relatedness criteria	Yes; dissemination, workplace inspections, cluster investigation that can be followed by epidemiological investigation
USA – Washington (1994)	SHARP Dermatitis Program	Washington State Department of Labor and Industries	Data mining from the workers' compensation database	No record	No record	Yes; dissemination, workplace interventions
USA – Washington (2002)	SHARP Asthma Program	Washington State Department of Labor and Industries	Reporting by physicians and data mining from the workers' compensation database	Collected through interviews of cases	No record	Yes; dissemination, workplace interventions
USA – Washington (from 1991 until 1999)	SHARP Musculoskeletal Disorders Program	Washington State Department of Labor and Industries	Data mining from the workers' compensation database	No record	No record	Yes; dissemination, workplace interventions

3.1.1 SUVA reporting system (Switzerland)

- **System's aim and objectives**

The SUVA reporting system is a compensation-based system and has a long history that begins with the formation of the Swiss National Accident Insurance Fund. Even though SUVA was initially directed towards occupational accidents, ODs were gradually introduced as one of the priorities of the system. Compensation claims can be submitted on condition that the OD is on the official list of ODs recognised by SUVA, or has a work-related causality of at least 75 %. The SUVA reporting system was created mainly to provide insurance to workers, but over time its objectives have expanded to include preventive workplace activities and the publication of national OSH statistical data.

- **Description of the system workflow**

Reporting parties

In the Swiss system, not a physician but the employer and the employee together are responsible for the reporting by law, but any physician can report to SUVA a case that might be work-related. Physician reporting is not required by law and is therefore based on voluntary participation. The physician involved should recommend the formal reporting of an OD to his patient. After formal reporting by the company, the physician performing the treatment has to make a medical report. In addition, every physician can report a case to the accident insurance fund with the consent of the patient, for example when a patient is no longer working as an employee. In practice, these reports are usually submitted by general practitioners (GPs), family physicians, OH physicians or other medical specialists. Occasionally, information sessions, congresses and training are organised for different groups of physicians to inform them of the possibility of and procedure about reporting to SUVA. Physicians can also be informed of the reporting system through the SUVA website and through numerous publications derived from the data collected.

Workflow

Data gathered by SUVA come mainly from two sources.

1. Compensation claims: all workers insured by SUVA can make compensation claims for occupational injuries and diseases. Compensation claims can be submitted on condition that the disease is on the official list of ODs recognised by SUVA, or has a work-related causality of at least 75%. Reporting was initially done by the human resource departments of companies using paper forms but is now mostly electronic. Electronic reporting forms have a standardised format and contain a set of items to be filled in by the reporting physician. Guidelines for reporting are provided. In the case of a compensation claim, OH physicians from SUVA often perform workplace inspections to gather additional data and perform a thorough investigation of the exposures and health risks.

2. Medical screening of workers: medical examinations of workers are performed by external physicians (mainly specialists in occupational medicine or general medicine). The aim of these examinations is the identification of health risks and the timely prevention of WRDs. The Swiss OSH law defines the presence of an increased risk of WRDs in certain groups, depending on which the frequency of medical surveillance to be performed differs among insured companies. Therefore, the medical examinations mostly target the specific groups of workers and economic sectors that are known to be at high risks of specific exposures, such as people working with quartz or asbestos and workers in chemical plants (for example making solvents). These are compulsory medical examinations carried out by SUVA (and paid for by SUVA). In addition, industries can request medical examinations at any time. SUVA decides if these examinations are performed and covered by SUVA. The enterprises can also take full responsibility for medical examinations. This medical surveillance can be initiated by a company, regardless of the legal reason for it. The examinations can include biomonitoring activities, exposure assessments, medical screening and so on, and these data are not transferred to SUVA.

Work-relatedness evaluation

All reported cases are evaluated by OH physicians from SUVA. Cases reported to other insurance agencies are judged within the agencies themselves, although they are not responsible for the prevention of ODs (only SUVA is), and are sent to SUVA after work-relatedness evaluation for statistical evaluation. These agencies also sometimes consult SUVA experts about their decision.

The law of accident insurance and its ordinance contains a list of harmful substances and ODs (*Liste der schädigenden Stoffe und der arbeitsbedingten Erkrankungen*). However, reporting is not restricted to this list. Health conditions that are not on the list may also be reported if they are backed by enough supporting evidence that the disease is work related. More precisely, 75 % of aetiology must be work related. In practice, this hinders the reporting of multifactorial disorders such as stress-related ill health and musculoskeletal disorders, as it is very difficult to prove their causal relationship to work with any high level of certainty. Nevertheless, the greatest impact of proof of causality is on the insurance aspect of the reported case and it does not inhibit any kind of preventive activities aimed at the detected health risks, even if the evaluation procedure does not class them as ODs.

Communication

SUVA encourages communication between reporting physicians and SUVA's OH experts. Reporting physicians can contact SUVA's OH experts at any time if they have doubts about an identified case. During workplace inspections, SUVA's experts investigate cases in more detail, and evaluate work-relatedness regardless of the opinion of the reporting physicians.

Data storage

All the data collected through case reports are stored in a database. This includes biomonitoring data on lead, mercury, solvents and so on. This database can be used for data mining, for instance to identify groups of workers at high risk or new/emerging work-related health risks. However, they are not available to the public except in the case of a research proposal submitted by an external party.

▪ Dissemination of results

SUVA produces annual reports, which summarise the statistics from all accident insurance providers derived from all data collected in the previous period. These reports are published on the SUVA website and are available to the public.

The information gathered by the SUVA reporting system is also disseminated though scientific publications (for example, Rusca et al., 2008; Koller, et al., 2016) and case reports. In addition, physicians can learn about the insights derived from the reported data through information sessions, congresses and training organised by SUVA personnel.

▪ Financial aspects

All the activities performed by the SUVA professionals are funded from the insurance money. All financial costs are provided from two main sources: insurance for ODs and accidents and the fund intended for preventive actions. This kind of division is important from the stakeholders' perspective, especially regarding the prevention budget, as it covers the financial expenses of the medical examinations of workers, which are linked not to compensation but only to prevention. On the other hand, the evaluation of work-relatedness expenses is covered by the insurance fund.

▪ Usage of data

Examples of data usage for prevention

Unlike most of the other systems described in the present report, which are characterised by preventive activities at a higher level (for example data input for policy recommendations and policy changes), SUVA provides a direct link with prevention aimed at individual workers at their workplaces or specific groups of workers at high risk. Both through medical surveillance and through the identification of ODs or WRDs by the SUVA reporting system, **workplace preventive actions can be triggered**. Triggers can include workplace inspections to identify the main causes of reported work-related conditions.

Assessment of workplace exposure will initiate advice on possible preventive measures against the identified risk.

One example of a link with prevention is a campaign targeting **skin problems in hairdressers**. This campaign was started after hairdressers were identified as having more skin problems than other professions. SUVA's OH experts informed employers in the hairdressing sector of this issue. In addition, workplace recommendations were provided to address these problems, and workplace checks were conducted to evaluate these actions. More information available at: https://www.suva.ch/de-ch/praevention/sachthemen/hautschutz

A similar set of actions was taken in the case of **skin cancer caused by ultraviolet radiation among outdoor workers**. After this was identified as an emerging risk, statistical data gathered by SUVA was used to justify and implement both individual prevention and technical interventions in the workplaces. More information available at: https://www.suva.ch/de-ch/praevention/sachthemen/sonne-hitze-uv-und-ozon

Examples of data usage for detection of new/emerging WRDs

There are different ways to give alerts on and report new/emerging WRDs. One way is to report a case directly through the official reporting system. However, the case must have 75 % of work-related causality if the condition being reported is not on the list of recognised ODs. It can be very difficult to provide enough evidence to support such high-level causality, especially with regard to certain groups of diseases. Thus, for some WRDs it can be easy to establish a high level of work-related causality, as in the case of allergies, whereas for others, such as mental health problems, it is almost impossible.

Another way to give alerts on new/emerging WRDs is through professional communication between reporting physicians and SUVA's OH experts as well as among the experts. In the department of occupational medicine at SUVA there are specialists in OH as well as in pulmonology, dermatology and so on, and communication between them takes place on a regular basis. This sometimes includes discussions about potential new and emerging OH risks. In cases of an alert of a possible new/emerging risks or WRD, SUVA's OH physicians and researchers often look for **other sources of complementary data**. For instance, they contact the other groups within SUVA working on the occupational exposure limits for additional investigation. They also often search for similar cases in other countries, such as Germany, the Netherlands, France, and Italy. In this way, several years ago, the link between skin cancers and ultraviolet radiation was identified as a possible new WRD risk. This can even lead to changes in the official list of ODs, on condition that the supporting evidence and rationale are sufficient for this kind of change. For instance, in the 1990s, **latex allergy** problems emerged, and this allergy was not on the official list of reportable conditions. However, after the OH physician who identified several cases contacted the SUVA reporting system, and a clear link was established with work-related exposure, SUVA recommended that the Swiss government add latex to the list of harmful substances. Similarly, **allergy caused by acrylates** was not on the official list until recently, but, if the reporting party had clear proof of work-relatedness, the case could be accepted and recognised.

Stress-related health problems at work and musculoskeletal diseases are important emerging risks reported by the companies. However, these health problems are seldom reportable to SUVA because they are not on the list of disorders caused by harmful substances and are basically impossible to acknowledge as work related with 75 % of work causality because of their multifactorial origin. Therefore, preventive activities regarding these health problems occur outside the SUVA reporting system. Nevertheless, the preventive services from SUVA work with both industries and OH physicians, for example on the **prevention of burnout**. Some companies require annual medical screening for burnout for all their workers. OH physicians provide feedback to these companies on the risks identified and advice on preventive measures to address them. OH physicians often talk to the employer and try to introduce possible changes in the organisation of the working environment and workload, which could have a favourable effect on the worker. Furthermore, physicians often analyse the risk of burnout in different departments of the company, pointing out specific groups of workers that are at higher risk and organisational aspects within departments that can be improved.

The approach to **work-related musculoskeletal problems** has recently changed. Previously, work-related musculoskeletal health problems were reported and evaluated not by OH specialists, but by

other medical specialists (orthopaedists and surgeons). The process of work-relatedness evaluation did not include workplace inspections, and the system relied on the experts' opinions, but this has been changed. Musculoskeletal problems are now becoming increasingly recognised as WRDs. The reason for this change is mainly that SUVA's physicians have more expertise in this domain to recognise and deal with these problems. In addition, they conduct workplace inspections and are provided with more information from the workplace through these inspections and in communication with ergonomists.

Other examples of data usage

As previously mentioned, SUVA is in charge of providing national OSH statistics. Therefore, the data gathered are used to follow **trends in OSH**. For instance, the analysis of data on work-related skin diseases showed a decrease in skin problems related to cement exposure, which was one of the leading problems in the 1990s. These data also led to the identification of emerging risks with regard to work-related skin diseases, such as cooling fluids in the metal industry (Koller, et al., 2016), epoxy resins and substances used by hairdressers, which are currently marked as the leading exposures.

- **Stakeholders' views**

Drivers and obstacles

Drivers	Obstacles
Excellent organisation of and communication with the professionals working in SUVA. Stakeholder 1 (owner): 'I think that, for the main risks and work-related diseases that are covered by SUVA, we have really good data. And it's easier for us because we are in the same company and we can speak with the people from the statistics department. We also have regular meetings, for optimisation. For the other insurance companies, I think it's a little bit more complicated. If they had more OH specialists, then it'd be easier for them, because I think there's a lack of knowledge within the insurance companies.'	The reporting of diseases that are not on the official list of ODs is challenging. The reason for this is mainly the mismatch between the part of the insurance system that provides compensation for ODs and the one that handles WRDs that are not on the official list. Stakeholder 1 (owner): 'So it's hard to distinguish whether a disease is occupational or not. And for the doctors, sometimes it's a bit complicated because, when the insurance hasn't decided yet and the decision isn't clear, then first they have to deal with the costs of the insurance for the diseases that are not occupational. And if, later, the decision is made that it is an occupational disease, you have to change everything.'
	The more complicated procedure of reporting diseases that are not officially recognised as occupational sometimes leads to under-reporting of these health complaints. Stakeholder 1 (owner): 'SUVA deals with a big number of occupational diseases. The other insurance companies, sometimes they don't have so many and they don't know how to deal with them very well. And sometimes they say, "oh no, it's not on the list". It's not an occupational disease and they don't know that you can actually prove that it's an occupational disease.'
	The quality of reporting and medical examinations performed by non-occupational professionals. This was also linked with the poor network of OH physicians in the country.

Drivers	Obstacles
	Stakeholder 2 (reporter): 'SUVA also delegates medical examinations to non-OH physicians. That means every GP can carry out the SUVA tests. Which has two consequences. First of all, from the quality perspective, the examinations are perhaps not perfect. And the second is that we have little opportunity to build our OH physicians' network in Switzerland because we don't have enough work-related examinations. If more of these examinations were performed by OH physicians or if the companies were obliged to have OH physicians, more occupational conditions would be reported.'

- **Quality of data**

One of the main features of data collection procedures that contribute to high data quality, in the view of all the interviewees, is the standardisation of all the steps in the reporting procedure. In addition to the standardised reporting form, the reporting process itself is extremely structured. This is ensured by well-organised communication between companies, physicians and SUVA, and a clear division of tasks. Nevertheless, data reported by OH physicians and GPs often differ in quality. Reports by (SUVA) OH physicians are mostly detailed, especially in terms of the work-relatedness of the possible exposures and risks present at the workplace to the disease. As stated by the owner of the system, the quality of the exposure assessment depends to a great extent on whether the case report was made with or without a workplace investigation conducted by an OH physician or industrial hygienist.

Stakeholder 1 (owner): 'When it comes to exposure assessment, I think the quality is not always so good. A big part of it is based on self-reporting, because there are not so many resources to make individual assessments of each case. And it also depends on the medical specialists who work in the companies. In cases where the exposure data are not clear, we go into companies with our colleagues who are OH physicians or occupational hygienists and we do the exposure assessment, for instance how much lead is present in the air. And this can't be done in all cases. But it's not always necessary, because there are cases that are very clear, or if you have some allergy or some reaction from a lotion, then it's not so complicated and you don't do the assessment. Sometimes we only know about the problem when it's solved because they made a change to the lotion or the substances.

- **Transferability to other countries**

When discussing the possibility of transferring a surveillance system such as the one maintained by SUVA, the interviewees pointed out that similar systems already exist in some countries such as Austria and Germany. These systems are also compensation based and have a similar structure regarding the reporting and recognition of ODs, WRDS and accidents. However, not all conditions have an equal status in terms of recognition. These particularities are closely related to the OSH systems in place in each country. Other compensation-based systems in other countries are quite different from that of SUVA, for instance the systems in France and Italy. Nevertheless, some strong points of the SUVA reporting system, such as the data quality, the expertise in assessing work-relatedness, and the direct link with workplace preventive actions and campaigns, are something that compensation-based systems from other countries could learn from.

3.2 Non-compensation-related systems for data collection and statistics

In the literature review, 26 representative systems from this group were selected and described. Moreover, three additional systems implemented in Spanish regions (García Gómez et al., 2017) were identified during the policy workshop and were subsequently added to the present report (see Table 4 and Appendix D for more detailed information):

- CSEP, launched in the Autonomous Community of the Basque Country;
- SISVEL, developed in Valencia; and
- EVASCAP, implemented in Asturias.

The list of the systems and their main characteristics is presented in Table 4. A common feature of the systems described in this group is that they were designed with the aim of improving the collection and analysis of data to measure trends in ODs and WRDs. These systems are completely independent from the national compensation systems and are often used to complement figures derived from the existing compensation-based systems regarding national OSH statistics. In some of these systems, monitoring new WRDs is recognised as an important aspect and is one of the surveillance objectives of the system. Consequently, these systems present a variety of innovative tools that make them suitable for monitoring new work-related risks and diseases. This category of non-compensation-related systems for data collection and statistics groups together the largest number of systems identified in the literature review from many European countries and several countries outside Europe. These systems are mostly nationwide and therefore are typically maintained by national occupational or public health institutes.

The majority of systems from this group have a broad scope and monitor **all types of WRDs**. In these systems, reporting parties are mainly physicians who encounter different types of WRDs in their clinical practice. These are mainly OH physicians or GPs, depending on the organisation of occupational health services (OHSs) in each country. In addition, several systems aimed at **a specific group of WRDs** were identified. The majority of these were designed to collect information on work-related respiratory diseases, but there are also schemes for monitoring work-related skin diseases, occupational cancer, work-related infectious diseases and diseases related to occupational exposure to nanomaterials. Reporting in this kind of system is performed by medical specialists, such as dermatologists in the case of work-related skin diseases, or pulmonologists or allergists in the case of work-related respiratory diseases, who are expected to see the majority of these diseases in practice. Finally, a few systems aim to monitor not only WRDs but also work-related injuries and accidents, and they allow employers and employees to submit reports.

Unlike in compensation-based systems, where reporting is insurance driven, these systems mainly rely on **voluntary participation of reporting physicians**. Therefore, motivation of these reporting parties to participate is one of the main drivers for the long-term sustainability and maintenance of this kind of system. However, the stakeholders interviewed involved in these systems emphasised the difficulty of keeping the reporting parties active, because of an increasing workload in their clinical practice. Perhaps this is the reason why many systems among this group are no longer active. These were mainly systems aimed at monitoring of work-related respiratory diseases previously implemented in several countries outside Europe (Canada, Australia, South Africa and so on), but also some systems in EU countries for work-related otorhinolaryngological disorders, musculoskeletal disorders, audiological disorders and mental ill health.

Regardless of the means of reporting cases (reporting form, online platform or telephone), all reporting parties are requested to provide data on the worker's gender, age, occupational title and sector of professional activity, exposures and diagnosis. Some systems request additional data on the WRD, such as information on the onset of symptoms, susceptibility and level of imputability (attributability of the disease to the identified exposure). When gathering data on **exposure**, these systems generally rely on 'subjective' reporting by physicians, who describe the suspected exposure together with the

other data while reporting cases. The lack of objective exposure data was seen by the interviewed stakeholders as one of the main weak points of these systems in terms of monitoring new work-related risks and diseases. As a thorough exposure assessment is a crucial step in order to establish a causal relation with work, improvement of this step could improve the suitability of these systems for the detection of new WRDs. Nevertheless, some systems seem to have dealt with this issue successfully and have implemented innovative approaches to adequate exposure assessment (such as the RNV3P system in France).

Once a case is reported to the system, systems from this group use two approaches to the **evaluation of work-relatedness**. Some systems rely on the decision made by the reporting physician with no further investigation, whereas in others the final decision on work-relatedness is made by experts from the acknowledged authority (usually the research centre that maintains the system). The second approach is better for monitoring new WRDs, as it is more likely to allow the identification of new links between exposure and disease. If the final decision on work-relatedness is made by the reporter, it is likely that only cases of already established WRDs, where work-relatedness is more obvious, will be reported to the system. This might be especially the case if reporting parties are not OH physicians, but other medical doctors, who might be less aware of potential new work-related health risks and diseases. On the other hand, if the team of OH experts who assess cases are aware of the potential new WRDs, it is more likely that these experts will identify and objectively assess potential new WRDs identified by the reporting parties. Nevertheless, raising awareness about new WRDs among reporting parties is an essential prerequisite for these cases to be noticed and captured by reporting parties. Some systems implemented in France – RNV3P and systems maintained by the French Institute for Public Health Surveillance (InVS) – have made progress in dealing with this issue, by forming specific groups of experts on new/emerging WRDs who assess reported cases.

The stakeholders interviewed for these types of systems reported that, after a case is recorded and assessed, different approaches are used to disseminate the data registered and, possibly, to initiate **preventive actions**. The most common means of disseminating the information and knowledge gathered by the systems are international papers, symposia, periodical newsletters/reports and websites. In most of the systems studied as part of this project, the link with workplace prevention is weak: only few systems perform follow-up actions, such as workplace inspections to implement necessary preventive actions or identify workstations at high risk of certain exposures. However, several systems have well-established communication with governing bodies, which enables them to provide OSH data and input to national preventive strategies and policies. They mostly provide input to identify vulnerable groups of workers, alarming changes in trends in OSH regarding specific diseases or industries and so on. This can then lead to the development of targeted preventive programmes and policies. Furthermore, experts of some of these systems communicate directly with the companies. For instance, experts from the THOR system (United Kingdom) receive requests for data analysis from different companies, and provide feedback, which is then used to support and implement preventive activities in these companies. Similarly, data derived from the Italian system called MALPROF are used to transfer information to local stakeholders such as companies, unions, workers' safety and health representatives, and local authorities in order to implement preventive strategies at a local or regional level.

In the following sub-sections, several systems are described in order to illustrate how these systems can be used for monitoring new/emerging WRDs and to give concrete examples of different approaches used to stenghthen their alert function. Three systems with a wide scope of monitoring all types of WRDs are described: the Norwegian Labour Inspection Authority's (NLI's) RAS, Occupational Health Surveillance Programme in Navarre (Spain) and MALPROF (Italy). In addition, two systems aimed at specific groups of WRDs are described: THOR (United Kingdom), which has several schemes for different groups of diseases, and EpiNano, specifically designed to monitor health effects of exposure to nanomaterials. Finally, the French RNV3P system is described to present its unique approach to data collection, alert signalling and link with prevention.

Table 4. Main characteristics of non-compensation-related systems described in the literature review

Country (start date)	System; type of WRDs/ODs reported	Organisation maintaining the system	Methods of data collection	Exposure assessment	Work-relatedness evaluation	Follow-up of new/emerging risks (yes/no); usage of data for dissemination/prevention
United Kingdom and Ireland (1989)	▪ The Health and Occupation Reporting Network for General Practitioners (THOR-GP); all ▪ Occupational Physicians Reporting Activity (OPRA); all ▪ Surveillance of Work-related and Occupational Respiratory Disease (SWORD); respiratory ▪ Occupational skin surveillance (EPIDERM); skin ▪ Surveillance of Infectious Diseases At Work (SIDAW); infectious ▪ THOR-EXTRA; all	Centre of Occupational and Environmental Health (COEH), University of Manchester	Voluntary reporting by GPs (THOR-GP), OH physicians (OPRA), chest physicians (SWORD), dermatologists (EPIDERM), infectious disease specialists (SIDAW) or any physician (THOR-EXTRA)	Described by reporting physician	Experts from the Centre of Occupational and Environmental Health (COEH), University of Manchester	Yes; dissemination through international papers/symposia, website, workplace inspection by labour inspectorate
Italy (2000)	MALPROF; all	Italian workers' compensation authority, National Institute for Insurance against Accidents at Work (INAIL)	Obligatory reporting by physicians (for instance OH physicians, INAIL insurance physicians, GPs, hospital specialists)	Obtained indirectly from work history	Occupational physician of the local health department	Yes; MALPROF report every 2 years, website to disseminate information and research results

Country (start date)	System; type of WRDs/ODs reported	Organisation maintaining the system	Methods of data collection	Exposure assessment	Work-relatedness evaluation	Follow-up of new/emerging risks (yes/no); usage of data for dissemination/prevention
Norway (1987)	RAS; all	Labour inspectorate	Obligatory reporting by physicians	Coded according to causal agents of European Occupational Disease Schedule based on information sent by reporter	Medical doctors in the labour inspectorate authority	Yes; dissemination through international papers/symposia/news-letters/reports, workplace inspections, planning of prevention activities
France (2003)	Surveillance programme of work-related diseases, Les maladies à caractère professionnel (MCP); all	InVS	Voluntary reporting by OH physicians	Described by reporting physician	A group of experts composed of epidemiologists from InVS, an occupational physician and a regional medical officer from the labour inspectorate	Yes; dissemination through international papers, reports, website
Netherlands (1997)	•National Occupational Disease Registry (NODR); all •Surveillance Project for Intensive Notification, Peilstation Intensief Melden (PIM); all	Netherlands Centre for Occupational Diseases (NCOD)	Obligatory reporting by physicians (NODR) or obligatory reporting by physicians who voluntarily participate in the project (PIM)	Described by reporting physician	Reporting occupational physician; OD specialist from NCOD checks all reports and can contact reporting parties for more information	No; dissemination through annual report, national-level data may also be used in planning prevention activities
Spain – Navarre (1998)	Occupational Health Surveillance Programme in Navarre; all	Instituto Navarro de Salud Laboral (INSL)	Voluntary reporting by physicians	Additionally assessed from information obtained from companies	Occupational physicians from INSL	Yes; periodical newsletters to summarise information for specific period, annual visits to INSL to discuss cases

Country (start date)	System; type of WRDs/ODs reported	Organisation maintaining the system	Methods of data collection	Exposure assessment	Work-relatedness evaluation	Follow-up of new/emerging risks (yes/no); usage of data for dissemination/prevention
Spain – Basque Country (2008)	CSEP; all	Department of Health and Basque Institute of Safety and Occupational Health (Osalan)	Obligatory reporting by physicians and OSH practitioners	Provided by the occupational health practitioners of the companies' prevention services	First assessment by Occupational Health Unit of Osalan	Yes; dissemination through reports, usage of data for prevention
Spain – Valencia (2010)	SISVEL; all	General Directorate of Public Health of the Department of Universal Health and Public Health	Obligatory reporting by physicians and OSH practitioners	Described by reporting physician and verification by occupational health units of the public health system	Experts from the occupational health units of the public health system	Yes; dissemination through reports and publications, usage of data for prevention
Spain – Asturias (2011)	EVASCAP; cancer	Regional Health Administration (Consejería de Sanidad)	Obligatory reporting by physicians and OSH practitioners	Described by reporting physician and verification by regional institute of OSH	Experts from the cancer assessment team (EVASCAP) of the autonomous administration	Yes; dissemination through reports, collection into a database (not public)
France (2001)	RNV3P; all	French Agency for Food, Environmental and Occupational Health & Safety (ANSES)	Reporting by physicians and data mining in the database	Usually described qualitatively by the reporter	ANSES experts in dedicated working group on emerging WRDs	Yes; international papers/symposia, reports, internal alert to clinicians in the RNV3P network, search for similar cases outside network, diffusion to authorities for necessary actions

Country (start date)	System; type of WRDs/ODs reported	Organisation maintaining the system	Methods of data collection	Exposure assessment	Work-relatedness evaluation	Follow-up of new/emerging risks (yes/no); usage of data for dissemination/prevention
France (2013)	French Registry of Workers Handling Engineered Nanomaterials (EpiNano); WRDs related to nanomaterial exposure	InVS	Several phases: 1) exposure registry of companies handling nanomaterials 2) data collection from workers by the EpiNano occupational hygienist and epidemiologist, and exposure assessment 3) repeated cross-sectional and cohort studies	On-site exposure data collection using standardised questionnaire	Group of experts not formed yet	Yes; annual reports, dissemination through journals of relevant professional societies involved, quarterly newsletters, brochures on hazardous respiratory agents at workplace, scientific articles, identification of workstations with high exposure potential
South Africa (1996 – not active since 2006)	Surveillance of Work-related and Occupational Respiratory Diseases in South Africa (SORDSA); respiratory diseases	National Centre for Occupational Health, South African Pulmonology Society, South African Society for Occupational Medicine, South African Society for Occupational Health Nurses and Department of Labour	Voluntary reporting by pulmonologists, OH physicians and OH nurses (reporting cases diagnosed by physicians)	Described by the reporting physician	Reporting physician	No; dissemination through journals of professional societies involved, quarterly newsletters, brochures on hazardous respiratory agents at workplace
Australia (1997 – scheme in New South Wales not active since 2008)	Surveillance of Australian workplace Based Respiratory Events (SABRE); respiratory diseases	Workers' Compensation (Dust Diseases) Board of New South Wales and Monash University	Voluntary reporting by OH physicians, respiratory physicians, and GPs	Described by the reporting physician	Reporting physician	No; presentation at scientific meetings and publications

Country (start date)	System; type of WRDs/ODs reported	Organisation maintaining the system	Methods of data collection	Exposure assessment	Work-relatedness evaluation	Follow-up of new/emerging risks (yes/no); usage of data for dissemination/prevention
Canada – Ontario (2007 – no longer active)	Ontario Work-Related Asthma Surveillance System (OWRAS); asthma, bronchitis, rhinitis or skin changes	No record	Voluntary reporting by pulmonologists, OH physicians, allergists or other physicians with an interest in ODs	Described by the reporting physician	Reporting physician	No; no record
France (2008 – not active since 2014)	Programme for Surveillance of Professional Asthma (ONAP2); asthma	InVS	Voluntary reporting by pulmonologists and specialised physicians working in OH departments of university hospitals	Described by the reporting physician and additionally validated by experts	Four experts review reported cases and probability of occupational asthma	Yes; dissemination through InVS reports
Italy (2000)	Italian Occupational Cancer Monitoring Information System (OCCAM); cancer	National Institute for Occupational Health (ISPESL), Italian National Cancer Institute in Milan	Data mining through Italian cancer registries and regional hospital discharge records for identification of cases, and data mining through electronic population files to identify controls	An individual is considered exposed to a given industrial sector if he or she has worked for a company in that sector for at least a year	No record	Yes – follow-up studies; dissemination through scientific articles, identification of high-risk economic sectors
United Kingdom (1996)	Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR); ODs on the prescribed list	No record	Obligatory reporting by employers and self-employed persons	No record	No record	No record
Singapore (2006)	iReport, one-stop reporting platform for occupational accidents, injuries and diseases; ODs on the prescribed list	Ministry of Manpower	Obligatory reporting by physicians, employers and employees	Described by the reporter	Medical doctors in OH clinics	No record

3.2.1 RAS (Norway)

- **System's aim and objectives**

The Norwegian Labour Inspection Authority's Registry of Work-Related Diseases (RAS) is a national registry run by the NLI. The central purpose of the system is to provide information to the NLI and facilitate workplace interventions and the prevention of hazardous exposures. In principle, the NLI's registry follows a sentinel health events (SHE) framework. A SHE is a preventable disease, disability, or untimely death that is work related, and provides the impetus for epidemiological or industrial hygiene studies or serves as a warning signal to initiate substitution of materials or processes, engineering controls, organisational measures or, as a last resort, personal protection, or to mandate medical care.

- **Description of the system workflow**

Reporting parties

When the registry system was developed further, it was decided that the form for reporting WRDs should have a low reporting threshold, in other words make it as easy as possible to report. All physicians can report cases. In 2015, OH physicians made the majority of the reports (65 %), followed by medical specialists in hospitals (21 %). Fewer than 10 % of the reports came from GPs. The physician receives a reward for reporting, corresponding to the average time they spend on compiling the necessary information on exposure, filling in the form and filing the report: NKR 150 (€16) for each accepted report.

Workflow

Reporting of work-related ill health to the NLI is spontaneous (performed once a physician decides) but all physicians are obligated by law to report (only on paper and by post). The reporting of work-related injury is not obligatory by law (only the reporting of work-related disease is), so if physicians wish to report injury the patients must consent (by date and signature on the form). A confirmed or suspected WRD is reported to the NLI by a physician on a WRD reporting form and sent to NLI by post. This reporting form – Labour Inspection form (154 b/c) – is relatively simple and the physician is required to provide the patient's identity, suspected relevant exposure, the identity of the employer at whose premises the suspected exposure took place, and the physician's own judgement about possible work-relatedness (Box 1).

Box 1. Data gathered using RAS reporting form

1. Personal information on reported person: name, age, sex, address, personal identification number, occupation.
2. Information on the employer at whose premises the exposure occurred: employer's name and address (at time of exposure), industrial classification code, whether the current employer is the same as when exposure occurred.
3. Diagnosis and causality: for diagnosis of either ICD-10 (International Classification of Diseases) or ICPC (International Codes for Primary Care), the following must be provided: the duration of exposure; occupational exposure factors; causal inference of positive, probable or possible; providing a description of the disease's course and/or case history is optional.
4. Intervention: Is an NLI intervention necessary? Has a copy been sent to the National Social Insurance Agency? Has the case been reported to the employer, the OHS provider, and the employer's insurance provider? The date and patient's approval for intervention with patient's signature must be included if an NLI intervention with the patient's name is necessary.
5. Physician's details: type of physician, name, address, telephone number, date, signature.

All work-related ill health can be reported. All illnesses and health problems that the physician has reason to suspect of being caused by the patient's work situation must be reported. Work-related illness and injury encompass far more than that which the National Insurance Act accepts as an 'occupational illness'. The Norwegian Ministry for Healthcare Services defines 'work-related diseases' as all conditions that are attributed to or exacerbated by exposures at the workplace (Kjuus et al., 2008: 27-30). However, not all WRDs are compensated for by the Norwegian Labour and Welfare Organization (NAV – social security agency). The WRDs that may be considered for compensation by NAV are listed. This list (Kjuus et al., 2008: 47) includes occupational hearing loss, respiratory diseases and skin diseases. Only the conditions present on this list of compensable WRDs are defined as ODs by the Norwegian Ministry for Healthcare Services.

The physicians are not required to prove that the reported disease is work-related. The report should be based only on suspicion of work-relatedness. The reporting form provides an opportunity for the reporting physician to recommend a case for NLI intervention. The physician marks the reported case 'Yes,' 'Unsure' or 'No', as it concerns a recommendation for an intervention. The reporting physician makes a recommendation for intervention if he or she either believes or suspects that the patient's illness is a result of occupational exposure, and deems an NLI intervention necessary. Informed consent of the worker/patient must be obtained if an NLI intervention with disclosure of the name of the patient is necessary.

If the reported health problem is on the list of ODs and injury benefits are applicable, the patient can take a copy of the report form to Social Security. Patients can also take a copy of the notification form to inform the employer and OHS of the conditions or need for adaptations.

As regards the coverage of the system, the offshore petroleum, aviation and marine sectors are not included in the monitoring; they are covered by other surveillance schemes. Nevertheless, the RAS is the most exhaustive system in Norway. A large number of SMEs are included in the RAS's target population.

Work-relatedness evaluation

The final decision on work-relatedness is made by the acknowledged authority in the labour inspectorate, and reporting parties receive feedback on the decision. A national group of experts from the RAS follows up the suspected cases.

Once the report form is filed, it is up to the labour inspectorate, the insurance scheme and/or specialists in occupational medicine to clarify the work-relatedness of the case and to determine to what extent the case is work related. Upon receipt by the NLI, reports are entered into an electronic database. The diagnosis and exposure factors on the reports are coded using the ICD-10 (WHO, 2011) and the European Occupational Disease Schedule's (European Commission, 2000) exposure codes, respectively. Coding personnel are trained in the two classification systems. The NLI's physicians supervise and assist the coding personnel in coding diagnosis and exposure factors. This measure helps maintain the integrity and quality of the data.

Although reporting physicians make a recommendation for intervention if they either believe or suspect that the patient's illness requires an NLI intervention, in some instances NLI physicians also recommend an intervention independently of the reporting physicians' judgement. Although the final decision to intervene at a worksite is made by the regional labour inspectorate, virtually all the cases recommended for intervention by either the reporting physicians or the NLI's own physicians are thoroughly investigated.

An NLI intervention typically involves a further assessment of the reported case and may involve postal correspondence or a telephone conversation with the employer, or a worksite inspection. By either telephone or post, the regional inspectors inform the reporting physicians who have recommended a case for NLI intervention of the reported case's status.

In some cases, an intervention does not take place, despite a physician's recommendation. The most common reasons for this are the employee concerned or reporting physician informs the regional inspectorate that the issue has been addressed; the workplace has closed down; or the regional inspectors have recently conducted an inspection at the workplace concerned and are aware of the problem.

Since the mid-1980s an additional copy of the reporting form may be submitted to the National Insurance Scheme, leaving the insurance scheme responsible for following up the case, for instance referring the worker to a clinical department of occupational and environmental medicine to have the work-relatedness scrutinised. Based on a comprehensive identification and quantification of previous exposure, and consulting relevant scientific literature, the department physician subsequently submits an expert statement to the insurance scheme. This statement serves as a basis for the insurer to judging work-relatedness; the insurer makes the decision on whether or not the exposure and the disease justify acceptance as an OD, in accordance with current legislation.

Communication

By either telephone or post, the regional inspectors inform the reporting physicians who have recommended a case for NLI intervention of the reported case's status.

To motivate physicians to file reports, they are told through feedback that reporting cases promotes prevention and may have positive consequences for patients. The feedback system must make it clear to the physicians that reporting is of great significance for both these reasons.

Data storage

Upon receipt by the NLI, reports are entered into an electronic database.

- **Dissemination of results**
  - The data have been utilised for initiating epidemiological WRDs studies (for example of asthma, cancers and dermatitis). These studies have given policy-makers and stakeholders a better understanding of WRDs and exposures.
  - The data contribute to the content of a WRD and injury newsletter published a few (one to three) times a year by the NLI and targeted at physicians. The intent of the newsletter is to increase awareness of WRDs among physicians, and in turn to encourage more physicians to report to the NLI.
  - The registry is one of the sources for the National Surveillance System for Work Environment and Occupational Health, which was established in 2006 to provide national statistics on work environments, including WRDs.
  - An annual report based on the data from the registry provides information on the yearly trends of reported WRDs. This information is taken into consideration while planning various national and regional campaigns.

- **Financial aspects**

No information available

- **Usage of data**

Examples of data usage for prevention

Work-related noise-induced hearing loss cases reported by physicians to the Norwegian Registry of Work-Related Diseases: data from 2005 to 2009

To provide an epidemiological profile of hearing loss cases reported to the Norwegian Labour Inspection Authority and the distribution of cases by the type of notifying physician, a study was based on the obligatory physician notifications of work-related illnesses to the NLI (the RAS). Noise-induced hearing loss (NIHL) data were extracted from this registry for the five years 2005-2009. Employment data were obtained from Statistics Norway by trade sector, gender and age to estimate the average number of cases reported in the period 2005-2009 and the incidence rates for the reported cases by gender, age and trade sector. Descriptive statistics for occupation and type of notifying physician were computed.

In the five-year period, a total of 7,888 NIHL cases were reported to the NLI. On average, 1,577 NIHL cases a year were reported; 96 % of these cases were in men. The incidence of reported work-related NIHL was estimated to be 66 per 100,000 workers. The incidence of reported NIHL cases was 6 per

100,000 for women and 120 per 100,000 for men. The highest incidence was found in the 55- to 66-year-old age group. The manufacturing, electricity, gas, steam, construction and mining sectors were found to have the highest incidence rates. OH physicians reported 85 % of all NIHL cases, whereas hospital and general physicians reported 7 % and 4 % of the cases, respectively.

It was concluded on the basis of this study that work-related NIHL remains a widespread yet under-recognised problem in Norway. Interventions targeting vulnerable groups are necessary to reduce noise exposure. The Registry of Work-Related Diseases is not ideal for detecting NIHL cases because of extensive under-reporting, and remedial measures should be taken to address this issue (Samant et al., 2013).

Occupational lung cancer in Sør-Trøndelag county

Although lung cancer can be caused by occupational exposure, this is not always recognised or reported, so not all patients receive the benefits to which they are entitled. Occupational case histories for patients from Sør-Trøndelag county with first-time diagnosis of lung cancer were collected. For comparison, the number of reported cases of work-related lung cancer from the Norwegian Labour Inspection Authority was obtained, and information on approval of occupational illness from the Norwegian Labour and Welfare Organisation (NAV). In total, 105 patients with lung cancer took part in the study: 73 men and 32 women. Among the men, 12 cases (16 %) were assessed as probably and 16 (22 %) as possibly work-related. Among the women, none of the cases were assessed as work-related. The reporting frequency from the other Norwegian health regions to the Norwegian NAV varied from 1.7 % to 5.1 %. Altogether, NAV granted injury compensation in 9 of the 12 likely cases and 5 of the 16 possible cases of work related lung cancer. This study found that approximately 20 % of the cases of lung cancer among men were occupationally related, and that the under-reporting of work-related lung cancer appears to be considerable. The obligation of doctors to report to the Norwegian Labour Inspection Authority should be made better known. Most likely, if patients had been aware of the opportunity to apply for this, more of them would have had their lung cancer verified as an occupational illness and could have received injury compensation.

Fish-processing case

On the basis of several reports of respiratory disease among workers at a fish-processing plant, the NLI chose to inspect the company, in particular on the processing of the fish. The inspection revealed a risk of the formation of bio-aerosols in one work process. The NLI ordered the company to survey the exposure to bio-aerosols and assess the health and safety risks of workers from this exposure. The company also had to take action and develop a plan to eliminate or reduce exposure to bio-aerosols. It prepared a plan to remove or reduce exposure to bio-aerosols. This meant looking for low levels of aerosol formation when purchasing new machines. The process was reviewed to see if the flow of water could be reduced, especially the use of water jetting under pressure. The work zones were changed so that water could flush away from the workers and down the floor instead of up in the air. In work zones where water might splash into workers' faces, the workers would have to use shields or goggles, and gloves when touching the fish. The general ventilation of the work zones was improved. Using the doctor's report about work-related illness, the NLI helped reduce the risk of exposure to bio-aerosols for all workers.

Examples of data usage for detection of new/emerging WRDs

Not available.

Other examples of data usage

Not available.

3.2.2 El programa de Vigilancia Epidemiológica en Salud Laboral en Navarra/Occupational Health Surveillance Programme in Navarre (Spain)

System's aim and objectives

The aim of the system is to minimise under-reporting of ODs. The first objectives were to assess the magnitude of the undetected damage to health by ODs (those which are treated in the public health system like any other disease) and to detect possible work-related health problems to initiate a preventive approach.

Navarre is one of the 17 autonomous regions of Spain. In this region, there is close collaboration between the Navarre Institute of Occupational Health and the Primary Care Directorate. Navarre also features a Programme of Occupational Health Units, whose main objective is to train professionals in the Primary Healthcare Labour and Research Programme on Occupational Diseases to recognise causes and propose preventive measures.

In 1998, the newly created Labour Epidemiology Section of the Navarre Institute of Occupational Health – Instituto de Salud Pública y Laboral de Navarra (ISPLN) – established an epidemiological Occupational Health Surveillance Programme, with the objective of studying the systematic under-reporting of ODs. It is a programme for detecting possible WRDs in patients attending health centres for primary care. The objective of the Occupational Health Surveillance Programme was both to assess the magnitude of the undetected damage and to seek out the pathology of possible work-related origin for prevention.

The epidemiological surveillance programme was based on the methodology of a sentinel system, which had already demonstrated its effectiveness in public health and in other countries. The detection of cases was based on Rutstein's concept of 'Sentinel Occupational Event' (Rutstein et al., 1983). He defined it as 'An illness, disability, or death avoidable, associated with an occupation and whose occurrence must: 1) motivate the initiation of epidemiological or industrial hygiene studies or 2) serve as an alarm signal for material replacement, facility control, use of personal protection or need health care.'

For the programme, five WRDs were chosen from the list of Mullan and Murphy (1991): elbow and wrist tendinitis, carpal tunnel syndrome (CTS), asthma, reactive airway dysfunction syndrome (RADS) and dermatitis. A pilot was carried out in two health centres. Subsequently, more centres were added to the programme, moving it from a sentinel system to a system covering a large part of the population (more than half of the health centres of Navarre were involved in 2005, with 213 physicians and about 70 % coverage of the population). Since 2013, the programme has been extended to all the region's health centres (56), which cover the entire active population of Navarre. In 2013, two extra WRDs were added to the surveillance programme: shoulder disorders, and voice problems due to nodules on the vocal chords. In addition to these seven diseases, the system also registers damage caused by work that is recognised neither as an occupational disease nor as an accident at work, such as common mental disorders (Moreno-Sueskun & García López, 2015).

- **Description of the system workflow**

Reporting parties

Physicians in primary healthcare.

Reporting mechanisms

The system is based on voluntary reporting by physicians. It uses a computer application that has an alert window to draw the attention of the physician when a newly entered event in the patient's medical history corresponds with a list of previously defined sentinel events. It encourages the physician to complete some items that identify the activity and/or occupation of the patient (worker). The system also requires an answer to three questions on the association with work (similar diseases seen in colleagues, improvement in periods of rest or vacation, and if the patient is unemployed). An advantage of the system is that cases both with and without sick leave can be reported. The system covers all workplaces including SMEs.

Cases can be reported with or without personal identification data. If the worker agrees, his or her personal details (first name, surname, address and telephone number) are added (the doctor specifically asks if the patient will allow the referral of the case to a specialised study). If the patient does not agree to have these personal details added, the case is submitted anonymously.

The limitation is that many cases are lost for follow-up because workers refuse to give their personal details: almost half of the workers do not consent to have the possible work-related origin of their ill health investigated. It is important to take this into account, especially when considering any obligation to report work-related ill health, since it seems that this would violate the will of many of workers, especially in such a complicated economic situation as the present one.

Other limitations are that often data necessary for valid assessment are initially missing from the report and it is not always possible to follow up cases because of problems in making contact.

Work-relatedness evaluation

The cases are then investigated by an OH physician, who can contact the employer and his or her OHS if necessary, initiate preventive measures and refer cases to the appropriate institutions to claim workers' compensation for OD. All notified events are recorded and subsequently analysed.

The sentinel events reported by the primary healthcare physicians are considered work related when confirmed by the OH physicians of the INSL. This confirmation is based on further investigation of the cases if the worker has granted consent (nominal cases) and uses the criteria for work-relatedness from the list of Mullan and Murphy (1991).

Communication

One of the main advantages of the Navarre programme is its operative case definition for each of the seven diseases, which, without greatly increasing the load of primary care centres, is a great help for the notification because it also includes criteria. Furthermore, there is close and permanent contact with the reporting physicians. In at least annual follow-up meetings, the interpretation can be discussed and adjusted.

Data storage

The data are transferred electronically to the Occupational Health Surveillance Programme Unit, respecting the confidentiality of the information at all times.

▪ Dissemination of results

A bulletin periodically summarises epidemiological information for specific periods and is disseminated to all the physicians included in the programme. The bulletins are available at: https://www.navarra.es/home_es/Temas/Portal+de+la+Salud/Profesionales/Informacion+tecnica/Salud+laboral/sucesos+centinela.htm

In addition, a visit to each of the centres is made annually, during which reported cases and annual results of the programme are discussed to strengthen communication.

▪ Financial aspects

Not available.

▪ Usage of data

Examples of data usage for prevention

Not available.

Examples of data usage for detection of new/emerging WRDs

Not available.

Other examples of data usage

Data are mainly used for statistics and analyses of trends.

Table 5 gives an overview of the number of reported cases since 2006. In 2013, two extra diseases were added.

Table 5. Spain: Number of reported cases in regional registry of Navarre

Year	2006	2007	2006	2009	2010	2011	2012	2013	2014	2015
Number of reports	709	738	539	614	659	699	634	1108	1188	1342

Source: ISPLN, Sección de Medicina del Trabajo y Epidemiología Laboral.

In 2015, a total of 1,342 cases were reported; 879 had personal details allowing further investigation (65.5 %) and 80 % of all cases were in men. In 607 (69 %) of the cases with personal details, it was possible to contact the worker and continue the investigation. In 75 %, it was determined that the case was indeed a WRD.

In relation to the type of work, the highest proportions of cases of carpal tunnel syndrome, elbow tendinitis, wrist and shoulder disorders were:

- among women, in catering services, retail, health services, caring for people and unskilled services;
- among men, in manufacturing industries, plant and machinery operation, mobile and agricultural labour, construction and manufacturing industries.

Both sexes had numerous cases of shoulder tendinitis in manufacturing and retail, and women had many in health activities and social services. Most cases of dysphonia occurred among women, mainly teachers. The number of consultations for mental health problems also grew, from 106 cases in 2014 to 130 in 2015, but these cases were not included in the surveillance system.

Table 6. Spain: overview of incidence of reported work-related diseases in Navarre, 2014 and 2015

Disease	2015		2014	
	Number of cases	Incidence per 100,000 workers	Number of cases	Incidence per 100,000 workers
Elbow and wrist tendinitis	571	186.3	537	171.0
CTS	182	59.4	151	48.1
Asthma/RADS	15	4.9	11	3.5
Dermatitis	107	34.9	114	36.3
Shoulder disorders	424	138.4	339	107.9
Voice disorders	43	14.0	36	11.5
Total	1342	437.9	1188	378.2

Source: ISPLN, Sección de Medicina del Trabajo y Epidemiología Laboral.

García López (García López, 2011a) analysed all occupational sentinel events reported by primary care professionals between 1998 and 2005. All of these were followed through to 2007. In the whole period, 2,055 cases were notified, 1,223 with personal identifications and 832 without (59.5 % and 40.5 %). These notifications included 1,192 cases of elbow and wrist tendinitis, 354 of carpal tunnel syndrome, 86 of asthma/RADS and 417 of dermatitis. The incidence rate is 332.8 per 100,000 workers in 2005 (Table 7).

Table 7. Spain: incidence of notified cases in Navarre, 2003-2005

Disease	2003		2004		2005	
	Number of cases	Incidence per 100,000 workers	Number of cases	Incidence per 100,000 workers	Number of cases	Incidence per 100,000 workers
Elbow and wrist tendinitis	169	113.45	391	201.75	386	195.91
CTS	66	44.31	109	56.24	114	57.83
Asthma/RADS	19	12.75	28	14.45	16	8.12
Dermatitis	64	42.96	146	75.34	140	71.02
Total	318	213.47	674	347.78	656	332.77

Source: ISPLN, Sección de Medicina del Trabajo y Epidemiología Laboral.

Of all cases, 49.9 % were in women and 50.1 % in men; 67.3 % were employed, 9.2 % were self-employed and the data of 23.5 % were not recorded. The mean age of the workers was 38.9 years.

From the cases with personal identification, a total of 982 (80.3 %) were investigated. For another 10.4 %, contact by telephone was not successful, and the rest were not investigated for lack of medical staff in the OH unit. Only 21 % took sick leave, and 10.5 % had come to primary care after being refused attention by occupational medical insurers. Of the investigated cases, work-relatedness was confirmed for 70 %, while for 20 % no conclusion was reached.

To determine if the reported WRDs were also reported to the official OD system, a search was carried out in the Historical Registry of Occupational Disease in Navarre (for the years 1989-2007). The finding was that 41 % of these WRDs were officially notified. Of the notified cases, 51 % were officially notified first and the remaining 49 % were notified after the worker was seen by a doctor in the public health system (García López, 2011b).

3.2.3 MALPROF (Italy)

- **System's aim and objectives**

MALPROF is a non-compensation-based system maintained by the Italian National Institute for Insurance against Accidents at Work or Istituto Nazionale Assicurazione Infortuni sul Lavoro (INAIL).

MALPROF is not directly linked to the other monitoring systems in Italy, but it complements the data collected by them. The main compensation-based system in Italy is a database of complaints and compensation claims regarding ODs, which is the database of the protection system managed by INAIL. Compensation claims are analysed and evaluated strictly from a medical-legal perspective, whereas

data gathered by MALPROF are oriented more towards prevention. MALPROF mainly aimed to provide OSH data that are not driven by legal aspects, in contrast to the national system for compensation claims.

The main objective of MALPROF is to provide data on work-related ill health through consistent reporting. Therefore, MALPROF plays the main role in establishing a uniform method of data collection for the local OSH units throughout the country. Given the issue of missing data on WRDs, the monitoring activity of MALPROF aims to provide a global overview of the burden of WRDs in the most comprehensive possible way.

MALPROF is not specifically designed to collect information on new/emerging WRDs. However, as the system aims to collect any kind of information on WRDs, early warnings are an integral part of the data gathering. No data are filtered a priori and therefore any information that arrives at the ASLs is recorded and evaluated. Nevertheless, certain quality conditions are required of the reported data to enable an adequate establishment of work-relatedness and causality.

- **Description of the system workflow**

A wide network of local prevention centres – aziende sanitarie locali (ASLs) – oversees the collecting of data on any type of work-related health complaint. In addition, physicians in the ASLs perform a thorough work-relatedness evaluation of cases and transfer the data into a national database maintained by INAIL.

Today, 16 regions (out of 20) are active members, and the remaining 4 regions will soon join the MALPROF national surveillance system.

Reporting parties

All kinds of medical professionals can report cases to the MALPROF system: doctors of the companies who put workers under health surveillance, GPs, medical specialists and so on. Any type of health complaints can be reported but the medical professional must suspect that the complaints may be related to work and they must provide the required information regarding the case.

Reporting mechanisms

A physician who diagnoses a disease potentially linked to the patient's occupational activity is required by Italian legislation to report the disease to INAIL and the ASL of the Italian national health service.

Each case report contains information on the diagnosis archived according to the Ninth Revision of the International Classification of Diseases (ICD-9), information on the sectors of economic activity and the professional qualification of the worker. This is basic information that is transmitted into the national archive. Some additional data are collected at the local level but are not stored in the national archive, in accordance with the privacy policy. This includes personal information about the worker: first name and surname, gender and age, which can be verified in the Registry of the Employees. In addition, some specific information on the company, including its name and address, is also available at the local level.

The system is very flexible in terms of disease diagnosis. Even though the diagnoses are normally classified according to the ICD, a clearly determined diagnosis is not essential for reporting a case. On the contrary, it is possible to report only signs and symptoms, if evidence of work-relatedness exists. This makes the system convenient for capturing all potential new/emerging risks and WRDs.

The reporting procedure has no standardised form. A standardised layout is necessary to classify all the gathered information in a homogeneous way. Some regions have a unified reporting model that allows notifications to be sent to both the ASL and INAIL simultaneously. However, INAIL requires the transfer of all assessment reports, in addition to the notification of the worker's health complaints.

Work-relatedness evaluation

One of the main strong points of the system is the in-depth analysis of each reported case, not only in terms of causal relationship with work, but also with regard to the quality of the collected data, which often indirectly affects the certainty of the work-relatedness evaluation.

All notifications received are analysed by medical doctors of the ASL prevention services. If needed, an in-depth analysis is done by the ASL doctor together with the doctor who reported the case. The ASL doctors assess the case, which is then recorded in the archive centre.

When performing the work-relatedness evaluation, the doctor chooses from a four-point range: 'highly unlikely' 'unlikely', 'likely', 'highly likely'. When the gathered information on the case is not very detailed but still sufficient to make an approximate evaluation, the doctor is further asked to express an opinion on the causal relationship more conservatively, using only 'likely' or 'unlikely'.

Basic and advanced MALPROF training courses are periodically organised for ASL personnel. During this training, the experts are informed of the data entry methodology of the software and, more importantly, they are instructed in the analysis of the causal relationship between exposures and WRDs.

Communication

Throughout the reporting and work-relatedness evaluation procedure, communication takes place on several levels. During a case evaluation by ASL experts, the reporting doctor may be contacted for additional information and a more thorough analysis of the case. Communication between the ASL and INAIL experts is two-way. After the case reports are transmitted from the ASL to INAIL, the INAIL professionals provide the ASL assessors with standardised tables that consider the correlations of specific interest in the reported case.

Data storage

The gathered information is stored at both the local level, within the ASL, and the national level, in a database maintained by INAIL and the Department of Research and Occupational Health.

After assessment by ASL experts, all case reports are sent to INAIL and are stored in the database in an aggregate form. All the information is transmitted online. The system provides access to web software through an internet browser, and the data are loaded directly from the territory and sent to the national archive. Currently, data uploading is still done at the local level by the ASL, but, thanks to software updates that are installed on personal computers, the files are automatically saved and sent to the archive centre by email, thus making data transfer more convenient.

The uploaded data in the national database are available to the general public, including the reporting parties and assessors themselves.

- **Dissemination of results**

Data are analysed annually, and every two years a report containing the data from the previous period is published. The reports are published in both traditional paper form and on the MALPROF website surveillance system, which has open access. Therefore, all the reports are available to the public. In addition, the online portal provides web applications intended to facilitate the consultation of the database. It is possible to create personal summary tables, by types of disease, sector of economic activity, territory and so on, to allow the users to obtain in-depth reports, according to specific needs.

- **Financial aspects**

MALPROF was initiated and financially supported by ISPESL from 1997 to 2010, in collaboration with other institutions. In 2010, ISPESL merged with INAIL because of a government decree. INAIL is the single institution in Italy responsible for carrying on the protection of workers. After this, the surveillance system has been supported by INAIL funds, which allow the use of, for example, software for data collection and transfer, and the publication of a biennial report. In addition, each region that joins the programme participates in funds to support these activities.

It was not possible to obtain the precise estimates of the costs of maintaining MALPROF. In general, the costs mainly include personnel expenses and some additional costs, such as software maintenance and the publication of periodic reports. The INAIL team is a small group of experts, consisting of about 10 people. The experts often perform multiple tasks within MALPROF in addition to managing and coordinating the system, which is the main role of INAIL at the national level.

- **Usage of data**

Data derived from MALPROF are used to guide national and local preventive actions, develop OSH policies, identify high-risk groups of workers and identify new/emerging risks and WRDs.

Examples of data usage for informing policy and prevention

The MALPROF data are used to guide health policies and preventive actions, at both the national and the local level. Whereas INAIL is the main mediator in integrating data from MALPROF and the national compensation system and using them for prevention and policy at the national level, the local and sub-local prevention units (ASLs) are responsible for developing local strategies, including workplace prevention.

For instance, MALPROF data are used at the regional level to communicate information to **local stakeholders**, such as companies, unions, workers' safety representatives, local authorities and so on, from both the workers' and the employers' side. This way, local stakeholders are informed of the local situation regarding work-related health problems, and of possible preventive solutions.

One example of the usage of MALPROF data for identifying high-risk groups and prevention is the investigation of **work-related health risks in the construction industry**. After a trend of increasing number of compensation claims was identified in this field, research was carried out comparing MALPROF data with those collected by the national compensation system. In addition, MALPROF was the only system that enabled the cases to be linked with the environment and industry, by providing exposure data. Therefore, the groups of diseases that were most widely reported were identified by analysing MALPROF data. This analysis revealed spine disorders as the most frequently reported among workers in the construction industry. Within this group of disorders, those affecting the lumbar spine in particular represented more than a third of the cases related to this type of pathology. Other disorders were also observed, but in less significant numbers. Moreover, after calculating proportional risk indicators, an excessive risk factor for knee injuries was found among workers in the construction industry. These conclusions led to preventive actions targeted at this specific industry. Such actions are generally adapted to the characteristics of a specific profession. In this case, they focused on finishers and tilers, who are more vulnerable to disorders of the lower limbs, particularly the knees.

In addition to the data derived from the INAIL compensation database, analysis of MALPROF data also contributed to the development of INAIL's National Plan for Prevention. Analysis of the reports from both national systems revealed a decline in traditional WRDs (respiratory diseases related to toxic substances and the accumulation of poisoning, work-related skin diseases and so on). On the other hand, musculoskeletal disorders were found to be one of the main emerging work-related health risks. This led to development of a three-year **national plan for prevention of musculoskeletal disorders**, which was recently approved. This national plan indicates several directions for preventive actions: active surveillance, training of participants and others in prevention, and improvement of the quality of risk assessment documents.

Examples of data usage for detection of new/emerging WRDs

As previously mentioned, MALPROF is designed in a way that enables the capturing of potential new/emerging WRDs and yet-unknown activity sectors or job titles potentially related to ill health. For this purpose, MALPROF experts apply the **proportional reporting ratio** (PRR), also used by the British Medicine Control Agency in the field of pharmacosurveillance (Evans, Waller & Davis, 2001), and already adopted by the French RNV3P (Bonneterre et al., 2008). The PRR is a measure of disproportionality commonly used for signal detection from spontaneous reporting systems of suspected adverse reactions (Puijenbroek, Bate and Leufkens, 2002). Within the MALPROF system, the PRR has been calculated as the ratio of the proportion of all reported cases of a specific disease among all reported cases of a specific sector/job title, compared with the corresponding proportion among all reported cases of all the other sectors/job titles. Its computational steps are identical to those used to calculate the relative risk in a cohort study. Using a two-by-two contingency table as an explanatory example (see Table 8), the PRR is computed as follows: PRR = [a/(a + b)]/[c/(c + d)].

Table 8: Example of two-by-two contingency table for computing proportional reporting ratio applied in MALPROF

Reports in function of sectors/job titles	Reports of disease under study	Reports of other diseases	Reports of all diseases
Reports of sector/job title under study	a	b	a + b
Reports of other sectors/job titles	c	d	c + d
Reports of all sectors/job titles	a + c	b + d	N=a+b+c+d

An example of a new WRD that had not been previously identified in the database of compensation claims is **cervical hernia**, which emerged in the clusters of reports submitted to MALPROF. While this disease has no solid scientific evidence of its relationship with work activities, evidence in the literature showed that cervical hernia is linked with a number of occupations, such as aeroplane pilots and surgeons. As this disease is not on the list of ODs in the national compensation system, MALPROF researchers carried out a further investigation. This study not only confirmed a higher risk among the occupations previously identified in the literature, but also revealed a recurrence of cervical hernia in some additional professions, such as drivers of articulated, heavy vehicles.

- **Stakeholders' views**

Drivers and obstacles

Drivers	Obstacles
The design of the system itself is the main driver to create an innovative surveillance system by using already available sources of information. The feasibility study was highlighted as the crucial step. Stakeholder 1 (owner): 'The feasibility study focused on the authority, on the ASL and in particular on the prevention services, which already had specific, comprehensive expertise in the field of occupational diseases as well as safety at work. The study put the focus on the information obtained as a result of in-depth investigations of those reports of diseases, often requested by the prosecutor to determine any possible liability. Therefore, the focus on an existing information source, never used before for surveillance and monitoring purposes, was a key element for enabling proper data stream management.'	The lack of national coverage of the system is seen as a drawback. In addition, stakeholders pointed out difficulties in terms of organisation and resources required for the activation and development of the system. Stakeholder 2 (reporter): 'The main obstacle is that it's not a zero-cost system because of the professionals who carry out this project, which is pretty challenging if it's done well: it's not just about taking into consideration the notification received about a possible relationship, but also about possibly integrating it with additional information that may allow a relationship to be established, even if the health service has not investigated it. So it's not free of charge.'
The work-relatedness evaluation performed by the expert ASL doctor is a driver. Stakeholder 3 (researcher): 'Defining a cause relationship is a specific activity of a medical	Some difficulties regarding technical support of data collection were reported by one of the researchers involved in MALPROF data analysis.

Drivers	Obstacles
doctor, pretty complex itself; however, we haven't needed to train additional professionals to work on different tasks in order to let this system work, because the doctors of the health service are used to establishing a cause relationship between employment status and pathology, even without any supervision.'	Stakeholder 3 (researcher): 'We have experienced considerable difficulties with the registration software that is supposed to support the collection of information: it's been modified several times and these changes have caused some major problems, major difficulties. Either because they've obviously modified the operators' routines – and this is something that always creates inefficiency, let's say so – or because every software update or modification has led to a loss of data that we've only been able to recover with great difficulty.'
The specificity of the work-relatedness evaluation procedure is also marked as the main driver in terms of identifying new/emerging risks and WRDs. Stakeholder 1 (owner): 'MALPROF's main feature is to be a surveillance system that links the disease and the causal relationship to the specific sector or professional qualification that has been identified as the field of origin of the exposure. Thanks to this feature, and therefore to the fact that it's a system that focuses on the collection of anamnesis data, it's possible to use appropriate indicators, like the proportional risk indicators. These indicators allow us to draw useful indications of an increased or decreased relationship with certain occupational diseases.'	The lack of standardised reporting forms sometimes leads to incomplete data reporting and missing information. Some specific regions have developed standardised reporting forms, and the stakeholders suggested that this approach should be implemented on the national level. Stakeholder 1 (owner): 'From a diagnostic point of view, we've verified that the quality of data coming from the doctors who reported the notification is good. If anything, the problem is the lack of a unique form, available on a national basis, with a set, standardised way of reporting the diagnostic information, especially that on work history. This is something we should work on, in order to provide an additional tool for those who send in the notification report.'
All stakeholders agreed on the simplicity of the descriptive statistical analyses and reports derived from the MALPROF data. This was mainly seen as a strong point rather than a weakness. The simplicity of reporting allows different sorts of stakeholders to examine in depth the transformation of the trends in OSH, how the framework and the distribution of different types of WRDs changes over time, and within the certain areas in particular. Stakeholder 2 (reporter): 'Surely the reports are very descriptive, very clear and accessible from any operator without any complex statistical analysis. So, I would say that the quality is good. It would probably be good to carry on some more advanced correlations from an epidemiological point of view or research, but I think that the result is sufficient for the needs of my level of work, which is to guide the planning choices with respect to the prevention of occupational diseases.'	

- **Quality of data**

One of the main strengths of MALPROF is the data quality analysis and the thorough work-relatedness evaluation that take place during the ASL physicians' assessment of cases. The evaluation is based on the experts' opinions on work-relatedness as well on the quality of the information available regarding a specific case. This way, all the opinions on the causal relationship are recorded and it is possible to distinguish a well-detailed set of reported data from a poor one, which in the latter case is consequently followed by a less precise work-relatedness evaluation.

Stakeholder 2 (reporter): 'So MALPROF itself is a system that already evaluates quality, and, based on this quality, determines the level of certainty of the relationship of the cause link, so it's strictly part of the system.'

The interviewees also agreed on the quality of the reported diagnosis.

Stakeholder 3 (researcher): 'MALPROF provides precise rules to follow in order to attribute a certain quality level to the given diagnosis, and so I'd say that these rules are followed closely enough by the doctors throughout the regions that are part of the system. This way, the quality is quite high, and unreliable diagnoses are quite rare.'

One of the main identified weak points of MALPROF is the lack of exposure assessment.

Stakeholder 1 (owner): 'MALPROF actually doesn't show an evaluation of the exposures' data; this is a "fault" of the system. We indirectly go back to evaluate whether there is a higher or a lower risk of exposure in a certain field, but the type and level of exposure within the system are not actually determined. It is not a matter of quality, it's just that the system strategically uses a different approach to allow the identification of a possible relation between the disease and the exposure.'

Even though the stakeholders expressed a clear need for a more detailed and accurate exposure assessment, they also pointed out that the adaptation of the data collection model in favour of exposure data could result in missing data. Therefore, some of the stakeholders suggested programming a new detection system that would focus on OH physicians as reporting parties, and a more detailed occupational medical history, thus working in an integrative way with MALPROF.

- **Transferability to other countries**

The stakeholders emphasised the particularity of MALPROF, which lies in the grounding of the system in the OD prevention network. This widespread network includes about 200 ASLs all over the country. The system is also characterised by a specific structure, with several levels of expertise in both public and occupational health. These particularities may make it difficult to transfer the system to a different context, mainly from a practical point of view. However, the stakeholders do believe that the model itself is replicable.

3.2.4 THOR (United Kingdom)

- **System's aim and objectives**

The THOR network was initiated in 1989, when its first scheme for occupational and work-related respiratory diseases (SWORD) began collecting data from chest physicians all over the United Kingdom. The initiative and support to develop this system mainly came from the Health and Safety Executive (HSE), whose main interest was to create a system that would fill in the gaps in OSH data collection in the existing systems in the United Kingdom. At that time, RIDDOR was the main source of OSH statistics. RIDDOR places duties on employers, the self-employed and people in control of work premises (the 'responsible person') to report certain serious occupational accidents, ODs and specified dangerous occurrences (near misses). However, data gathered by RIDDOR were limited by massive under-reporting of cases and their insufficiently detailed description. Therefore, the HSE encouraged the development of THOR in order to fill in these gaps in OSH data collection and to provide a more reliable source of epidemiological data and statistics in the United Kingdom.

More specifically, two main outcomes were predicted for the THOR system: the first was the production of annual statistics, including a cross-tabulation of data by age, gender, region, occupation, industry and agent; and the second was an annual report on trends and incidences. However, many other outputs gradually arose from the data gathered by the THOR schemes. For instance, project assistants on the THOR schemes and other researchers receive various data request services in which the HSE, THOR reporting parties or other parties ask for specific data (concerning, for instance, a specific economic sector) and, upon this kind of request, a data search is completed and sent out in the most suitable form. Furthermore, even though detecting new/emerging work-related health risks and diseases was not one of the initial goals, it can certainly be considered one of the current aims of the system.

- **Description of the system workflow**

The first scheme launched was the **SWORD** scheme for respiratory diseases (1989), but several other schemes were implemented in the following years. In 1993, the scheme for dermatologists (**EPIDERM**) was established. In 1996, the reporting scheme for OH physicians (**OPRA**) was implemented and the OH physicians who used SWORD to report cases started reporting to the OPRA scheme. In the same year (1996), another scheme was begun: Surveillance of Infectious Diseases at Work (**SIDAW**). In the following years, four more schemes were established. They collected data for several years but are no longer active: **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, reported by psychiatrists) (1999-2009) and **THOR-ENT** (Occupational Surveillance of Otorhinolaryngological Disease, reported by otorhinolaryngologists) (2005-2006). The main reason for their demise was at least partially financial. At a certain point, the HSE no longer provided the funding for these schemes, and the costs became hard to manage.

However, in the cases of MOSS and SOSMI, another reason for their discontinuation was the start-up of THOR-GP in 2005. As psychiatrists and rheumatologists tend to see work-related ill health at the most severe end of the scale, this could result in a gap in knowledge regarding the less severe cases, which are not referred to clinical specialists. Therefore, one of the objectives of **THOR-GP** was to plug this gap and provide data on cases of work-related mental ill health and musculoskeletal disorders seen in their daily practice. Moreover, rheumatologists and psychiatrists appeared to be less motivated than the other reporting parties, possibly because of difficulties in attributing musculoskeletal or mental health problems to work, and their multifactorial origin.

On the other hand, GPs did not report many cases of skin or respiratory WRDs in their daily practice; therefore, SWORD and EPIDERM remained the principal monitoring schemes for respiratory and skin WRDs. In addition, it seemed that dermatologists and chest physicians could confirm work-relatedness with more certainty.

The current organisation of different schemes enables two levels of coverage: whereas THOR-GP and OPRA provide information from workers who seek medical help for their complaints for the first time, the specialist schemes SWORD, EPIDERM and SIDAW capture information about cases referred to these three groups of medical specialists. In terms of disease severity, THOR-GP and OPRA are expected to capture less severe cases as well as work-related mental health and musculoskeletal ill health, which are mainly handled by GPs in daily clinical practice. On the other hand, specialist schemes can provide a complementary information about more severe cases, especially in the case of work-related respiratory and skin diseases, which are shown to be more likely to be referred to specialists than work-related mental health problems or musculoskeletal diseases. Regarding cases of work-related hearing impairments and otorhinolaryngological diseases previously covered by corresponding specialist schemes (OSSA and THOR-ENT), there was no further information about the potential gaps in capturing these diseases because the specialist schemes were discontinued.

The most recently implemented scheme is specifically designed for reporting interesting cases or the ones with potentially novel causes (THOR-EXTRA). This scheme has no clear criteria for the definition of an ‘interesting’ case; physicians can report on either a novel cause or something unusual that they do not normally see in their practice. SWORD, EPIDERM and OPRA were also implemented in Ireland in the mid-1990s.

Table 9. Overview of THOR schemes

Name of scheme	Reporting parties	Start date	End date (if applicable)
Surveillance of Work-related and Occupational Respiratory Disease (SWORD)	Consultant chest physicians	1989	-
Surveillance of Work-related Skin Disease (EPIDERM)	Consultant dermatologists	1993	-
Occupational Physicians Reporting Activity (OPRA)	OH physicians	1996	-
Surveillance of Infectious Diseases at Work (SIDAW)	Consultant infectiologists	1996	-
Occupational Surveillance Scheme for Audiological Physicians (OSSA)	Consultant audiologists	1997	2006
Musculoskeletal Occupational Surveillance Scheme (MOSS)	Consultant rheumatologists	1999	2009
Surveillance of Occupational Stress and Mental Illness (SOSMI)	Consultant psychiatrists	1999	2009
Occupational Surveillance of Otorhinolaryngological Disease (THOR-ENT)	Otorhinolaryngologists	2005	2006
Health and Occupation Reporting Network for General Practitioners (THOR-GP)	GPs	2005	-
Health and Occupation Reporting network-Extra (novel causes) THOR-EXTRA	Reporting parties from all other schemes		-

Reporting parties

THOR schemes were intended for different groups of physicians and WRDs. Three of the schemes are disease specific: SWORD for work-related respiratory diseases diagnosed by chest physicians, EPIDERM for cases of work-related skin diseases reported by dermatologists and SIDAW for infectious diseases seen by infectiologists. On the other hand, the other two schemes cover all types of WRDS, diagnosed by OH physicians in OPRA or GPs in THOR-GP. Physicians are invited to report cases they see during their usual clinical practice that they think might have been caused or aggravated by work. Reporting is voluntary for all the schemes. All physicians can report to THOR-EXTRA if they come across an interesting case or a possibly new work-related health risk or disease.

In most of the schemes (SWORD, EPIDERM, OPRA and THOR-GP), there are two types of reporting parties: 'core' reporting parties, who report every month, and 'sample' reporting parties, who report cases for one randomly assigned month per year. The categorisation of physicians into these two groups of reporting parties varies from scheme to scheme. For SWORD and EPIDERM, the 'core' reporting parties tend to be a voluntary group of very keen specialists who possibly see many cases in daily practice. For OPRA, all OH physicians were sample reporting parties at the beginning. At a certain point,

the THOR researchers conducted a study to investigate the impact of sampling frequency on reported disease incidence. For this purpose, several OH physicians who had previously reported a high number of cases were invited to be the 'core' reporting parties. After a year, the 'sample' and 'core' reporting parties were swapped. Finally, at the end of the study, those who wanted to remain 'core' reporting parties did so: approximately 20 physicians. This number increased over time to reach the current 34 'core' reporting parties to OPRA. In contrast, in the THOR-GP scheme, all reporting parties were originally 'core' but, because of financial issues, they gradually crossed over to be 'sample' reporting parties. Currently, all reporting parties in this scheme are 'sample', and 'core' reporting no longer takes place. If 'sample' reporting physicians come across a case outside their reporting month, they can report it to the THOR-EXTRA scheme at any time.

Reporting mechanisms

When THOR started, all reporting parties used a postal report card, apart from the THOR-GP scheme, which was exclusively electronic from the start. There are currently several reporting options. Physicians can still send a postal report card, report by online form or even phone to report a case.

Similar data are gathered in all the schemes and include the age and gender of the worker, postcode (region), occupation, industry, diagnosis, causal agent(s) and date of onset of symptoms (month and year). The THOR-GP scheme collects some extra data, such as information regarding sickness absence and whether or not the case has been referred to a specialist. When reporting to OPRA, information on the reason for medical examination must be provided (such as referral for routine health surveillance, pre-employment or pre-placement, sickness absence). This information is filled in on reporting cards designed for each of the schemes. An online form corresponds to each reporting card. Physicians can also report the data required for an identified case by phone.

Physicians are also allowed to report as part of a group, whereby all physicians within the group report their cases to a group lead who collects them and submits them to THOR. Another option is to delegate the reporting task to another member of the clinical team (such as a clinical nurse), as long as the diagnostic standard remains the physician's responsibility. These alternative ways of reporting are intended to ease the time constraints on the reporting physicians.

Work-relatedness evaluation

Generally, the final decision on work-relatedness is made by the reporting physicians, and further investigation of each reported case does not necessarily occur. However, there is a certain amount of quality control in terms of the determination of work-relatedness. First, physicians can contact experts from the University of Manchester at any time if they have doubts about whether or not a case is work related. Second, a new concept called EELAB (Electronic, Experiential Learning, Audit and Benchmarking), introduced to the THOR system in 2007, allows physicians to audit themselves clinically.

This tool has been integrated into online reporting and provides additional information to the reporting physicians. So, for instance, if a physician types in the information regarding a case of work-related back pain, links will appear that can lead him or her to additional information on the back pain in question or similar cases already described. This can help physicians in deciding on work-relatedness in individual cases. The main objective of EELAB is simultaneous teaching and learning through data entry. It is also intended to encourage online reporting of cases, as this tool cannot be used when reporting on paper (using reporting forms). An additional motivation for reporting parties to use EELAB is that they can claim continuing professional development credits by using this online tool. The EELAB was first accredited by the Royal College of General Practitioners, and a few years later by both the Royal College of Physicians in the United Kingdom and the Royal College of Physicians of Ireland. Thus, it is currently possible to gain continuing professional development credits in two schemes: OPRA and THOR-GP. Implementation in the rest of the schemes is in progress.

Finally, another round of work-relatedness assessment occurs on the level of data coding and analysis. The researchers at the University of Manchester regularly perform data cleaning and transfer to databases, and during this process they contact reporting parties if they come across any unusual data or if they need additional clarifications regarding the work-relatedness of the reported case.

Communication

The reporting parties and the researchers who assess the cases constantly communicate. In case of any doubts regarding work-relatedness, the reporting parties can contact experts from the University of Manchester to resolve any uncertainties. Furthermore, an annual meeting for each group of reporting parties is organised. Some of the key reporting parties from each scheme are invited to attend the meeting.

Data storage

The main person in charge of data storage and analysis is the project assistant assigned to each THOR scheme. The project assistants code data, by using the Standard Occupational Classification and the Standard Industrial Classification (McDonald et al., 2005). In the case of information on the causal agent, in-house coding is used, which is developed in agreement with the HSE. Two assistants perform the coding independently, and any doubts are discussed with a senior researcher. Afterwards, the cases are entered into a database. Each specific scheme has its own corresponding database. The cleaned data extracted from each database are then transferred into one master database. This master database is used to export data into the SPSS software and perform different statistical analyses.

- **Dissemination of results**

1) The annual statistical report is sent to the reporting physicians and to the HSE in June each year. This report contains summarised data collected by THOR (all schemes) throughout the previous calendar year. Data are published on the HSE website: http://www.hse.gov.uk/statistics/tables/index.htm#thor

2) The annual report of incidences of and trends in work-related ill health is sent to the HSE each year. These data are also published on the HSE website: http://www.hse.gov.uk/statistics/tables/index.htm#thor

3) Quarterly reports are sent out every three months to reporting physicians as well as to the HSE. Each report contains data gathered by all the schemes for the previous quarter. Furthermore, the reports often contain descriptions of interesting cases or new/emerging health risks and WRDs. For instance, a special section called 'The Beck Report' always contains a description of an interesting case reported to the EPIDERM scheme for dermatologists. In addition, all news on the THOR systems is included in the quarterly reports.

4) Data are also disseminated in the form of scientific papers and articles (Money et al., 2015a,b; McDonald et al., 2005; Meyer et al., 2002; Hussey et al., 2013; Carder et al., 2011; Stocks et al., 2010).

5) Specific data can also be analysed upon ad hoc data requests from different parties (for example reporting physicians, HSE, industry, research institutions).

   Participating physicians have requested THOR data on topics including:
   - occupational farmer's lung;
   - asbestos disease among firefighters;
   - respiratory disease among welders;
   - work-related mental health conditions by age of workers;
   - hand-arm vibration syndrome/vibration white finger among orthopaedic surgeons/health workers.

6) Advisory committee meetings for each scheme are held once a year, enabling physicians to learn about recent research related to their speciality and to take part in THOR's future plans.

- **Financial aspects**

It is difficult to determine exactly the financial expenses of maintaining the THOR system. One of the reasons for this is the existence of several different schemes, the funding of which has not always been supported by the same source.

THOR was financially supported and initiated by the United Kingdom's HSE. THOR was initiated in 1989, when the first scheme, SWORD, was launched. At that point, SWORD was intended for chest physicians' and OH physicians' reports. The initiative emerged from collaboration between the HSE, the University of Manchester and the British Thoracic Society. The financial support to begin the SWORD scheme came from the HSE, which has since then provided part-funding for the overall THOR system.

Several other schemes were implemented in the following years. In 1993, the scheme for dermatologists (EPIDERM) was established, again funded by the HSE, with additional inputs from the British Association of Dermatologists and the University of Manchester. In 1996, the reporting scheme for OH physicians (OPRA) was implemented and the OH physicians who used SWORD to report cases started reporting to the OPRA scheme. As with the other two schemes, OPRA was funded by the HSE, but this time with inputs from the Society of Occupational Medicine. In the same year (1996), another scheme was begun: SIDAW.

The cost does not multiply with the addition of each scheme, as many core activities are not influenced by the number of schemes. However, some data were obtained on the budget proposals at different phases of the system. At the time when the HSE was the only source of funding, the budget proposal for a five-year period and six schemes that were active at that time was about GBP 5 million. A proposal for the funding of two schemes (SWORD and EPIDERM) for 2017 included a budget of around GBP 200,000.

- **Usage of data**

Examples of data usage for informing policy and prevention

Data gathered by THOR are one of the main sources for the HSE to **determine OH priorities and work programmes**. Identifying high-risk industries and sectors has helped to target some industries more than others in terms of preventive policies, and to provide evidence bases for the HSE's campaigns and interventions. Both the THOR network and the HSE have continual impacts on setting priorities in both prevention and research. On the one hand, some priorities are set methodologically, emerging from the statistically analysed data. On the other hand, certain priorities in terms of hazards are first highlighted by the HSE, which further induces more thorough investigation by the THOR researchers. So, for instance, if a specific WRD is stressed by the HSE, THOR staff look at not just the incidence but all the determinants, all sorts of exposures that can cause the disease and so on. For the period 2002-2014, the HSE submitted approximately 200 enquiries to THOR, requesting information on cases reported in specific areas of interest.

For instance, in 2008, the HSE received a request to estimate cases of pleural diseases reported to SWORD and OPRA between 2002 and 2006 by year and gender (Money et al., 2015a).

Data are constantly being used to refine research objectives in terms of mechanisms of disease, determinants of disease, prevention of disease and methodology for data collection.

THOR data also **provide an input for informing Parliament**. For instance, they are a source of evidence to select committees, and parliamentary questions directed at government ministers. Various public bodies such as the Industrial Injuries Advisory Council and the HSE's Asthma Partnership Board solicit data to help inform their decisions.

One example of the use made of THOR data is the Revitalising Health and Safety Strategy, a 10-year strategy to improve health and safety at work. More specifically, the aim was to reduce the impact of health and safety failures by 30 % during this period. THOR was the main data source for measuring this target, alongside RIDDOR and the Labour Force Survey. THOR data showed a significant decrease in work-related asthma and contact dermatitis between 1999-2000 and 2009-10. The overall trends derived from the THOR data were particularly useful for policy-makers thanks to multilevel models (MLMs) that enable investigation of change in incidence over time, taking into account the factors that can influence 'true' incidence, such as variations in the number of reporting parties, seasonal patterns in reporting, and a decrease in reporting due to reporting fatigue.

Some other concrete examples of how THOR data are used for informing policy and prevention are:

- the HSE pocket book *Bakers! Time to clear the air*, developed in response to THOR data identifying bakers and confectioners as a high-risk group. Available at: http://www.hse.gov.uk/pubns/indg429.pdf
- the *Asthma Workplace Charter*, developed by Asthma UK in consultation with the HSE, which uses THOR data as the basis for its list of the main occupations at risk of developing work-related asthma. Available at: http://www.hse.gov.uk/pubns/asthma-at-work-your-charter.pdf;
- how THOR data influenced the choice of trades and case studies highlighted on the HSE's asthma website (http://www.hse.gov.uk/asthma/);
- the House of Lords Science and Technology Committee inquiry into allergy, which cited THOR as a source for its statistics (see The House of Lords Science and Technology Committee, The 6th Report of Session 2006-07, available at: https://publications.parliament.uk/pa/ld200607/ldselect/ldsctech/166/166ii.pdf);
- how THOR data have helped identify HSE priorities for intervention, such as the Bad Hand Day campaign launched in 2006 to raise awareness of and prevent work-related dermatitis in the hairdressing industry. More information at: http://www.hse.gov.uk/hairdressing/bad-hand.htm;
- the Inspection Topic packs, produced by the HSE, which provide advice to inspectors, for example its pack on the *Control of isocyanate exposure in motor vehicle repair (MVR) body shops*, which cites EPIDERM data in claiming that vehicle paint sprayers are one of the top 10 occupations suffering from occupational dermatitis (available at: http://www.hse.gov.uk/foi/internalops/fod/inspect/mvrtopicpack.pdf);
- the *NHS Plus/Royal College of Physicians evidenced-based guidelines on latex allergy*, which cites THOR data to substantiate the impact of preventive measures. Available at: https://www.nhshealthatwork.co.uk/images/library/files/Clinical%20excellence/Latex_allergy_full_guidelines.pdf.

Examples of data usage for detection of new/emerging WRDs

Even though THOR was primarily designed to provide OSH statistical data, this system is also a valuable tool for detecting new/emerging work-related health risks and diseases in various ways. Sometimes, researchers who screen the data collected by all the schemes detect cases of new/emerging WRDs. This triggers further investigation of possible work-relatedness, a search for similar cases in the literature, feedback and communication with the reporting party of the case and so on. These cases are usually **described in the quarterly newsletters to inform all the reporting physicians** and raise awareness of the potential new/emerging risks and WRDs. This kind of new knowledge is also integrated into the **EELAB system**, so that physicians who come across similar cases in the future can learn about these new risks and decide if they are associated with work. Furthermore, the THOR-EXTRA scheme was designed specifically to collect data on WRDs that have not been previously recognised, and to begin to identify new causal agents. All reporting physicians can report suspected cases to THOR-EXTRA at any time, and work-relatedness is then further investigated by experts from the University of Manchester. Below are some examples of new/emerging work-related risks and diseases identified by THOR.

- The association between scleroderma and solvent exposure.
- Occupational dermatitis in vehicle paint sprayers associated with isocyanate exposure.
- Work-related asthma associated with cyanoacrylate exposure in fingerprint specialists working in forensic investigation, and work-related asthma in funeral wreath manufacturers associated with isocyanate exposure. These cases were identified by applying the data mining technique developed in the French RNV3P in order to identify new cases of work-related asthma in the SWORD database.
- Occupational asthma caused by heated triglycidyl isocyanurate (TGIC). TGIC is a hardening agent used in powder paints. Previously, TGIC has been reported as causing allergic eczema

and occupational asthma in powder paint sprayers. Eleven reports to SWORD between 1989 and 2010 were attributed to TGIC, and OH physicians reported two cases of TGIC asthma to OPRA. A new exposure scenario was identified after six cases of occupational asthma had been reported and associated with indirect exposure to heated TGIC. Five workers were employed in the same factory and were in charge of making domestic gas fire appliances that were assembled and tested in an open plan area. A powder coat containing 10 % TGIC was electrostatically applied to gas fire appliances to provide a protective and decorative finish. The sixth identified subject worked in a factory in which architectural metal products were spray-painted with powder coatings containing TGIC. All the six workers developed occupational asthma, confirmed by serial peak expiratory flow measurement and analysis using Oasys software, and were removed from the exposure (Anees et al., 2011).

- SWORD data are used in conjunction with techniques such as quantitative structure activity relationships (QSAR) to help identify or predict novel asthmagens. QSAR models in general are regression or classification models used in the chemical and biological sciences and engineering. QSAR modelling tries to predict, for instance, biological activity from the physico-chemical properties or theoretical molecular descriptors of chemicals. The QSAR method was initially developed in the pharmaceutical industry to predict the adverse effects of drugs, such as skin sensitisation, mutagenicity, carcinogenicity and teratogenicity. This method was validated for respiratory sensitisation and is used to observe possible links between a chemical's structure and its asthmagenic potential by searching though the SWORD database (Jarvis et al., 2015). Currently, this idea is being extended to the feasibility of applying QSAR to identify novel agents for other THOR data, for instance contact dermatitis.

Examples of other usage of data

As previously mentioned, THOR data are primarily used to describe the incidences and trends in WRDs in the United Kingdom. At the simplest level, this involves providing an overview of the burden of disease, including how this varies according to different factors such as age, gender, causal agent, occupation and geography. However, as THOR gradually became responsible for producing the nationally representative OSH statistical data, several methodological challenges arose, which led to the **development of sophisticated statistical methods**. This includes methodological advances with regard to determining absolute incidence rates of diseases by factors such as type of diseases, age and gender. However, determining disease incidence rates in relation to specific exposures is more of a problem, mainly because of the difficulties in quantifying the exposed population. It may be easier to identify the exposed population for some types of agents (for instance coal or flour) than for others (such as soaps and detergents). The THOR researchers dealt with this problem by determining relative rather than absolute trends in incidence.

In addition, one of the most significant advances in THOR methodology has been the **use of multilevel models to investigate the change in incidence over time**. This method enables taking into account and adjusting for various factors that can influence the trend, including variations in the number of reporting parties, seasonal patterns in reporting, a decrease in reporting over time due to 'reporter fatigue' and so on. Another issue addressed by THOR is potential biases in the population covered by THOR, for instance towards specific industries, as exemplified by OH physicians reporting to OPRA, or biases arising from participating physicians having a different reporting culture from physicians in general, as GPs participating in THOR-GP have a diploma in occupational medicine, unlike GPs in the United Kingdom in general.

Data gathered by THOR are also used to **evaluate different preventive measures already in place**. For instance, in 2005, Directive 2003/53/EC of the European Parliament and of the Council amending for the 26th time Council Directive 76/769/EEC relating to restrictions on the marketing and use of certain dangerous substances and preparations (nonylphenol, nonylphenol ethoxylate and cement) was incorporated into United Kingdom law. After this, THOR data were analysed and revealed a reduction in the incidence of allergic contact dermatitis in the construction industry after the banning of cement

containing significant amount of chromate (Stocks et al., 2012).

In addition, the THOR data were analysed with the objective of identifying trends in the patterns of disease reporting and trends in diagnostic labels. For instance, THOR data (1996-2009) showed a trend of decreasing incidence of musculoskeletal reports accompanied by a trend of increasing incidence of mental disorders. The THOR researchers interpreted these data to mean that there was no sudden change in the pattern of the diseases themselves, but that a change had occurred in the reporting and presentation of the diseases. Patients who in the past might have complained about musculoskeletal symptoms would now probably admit to being anxious, stressed or depressed because of their work.

Some additional studies were used to **determine how different physicians would report the same conditions**. For example, a comparative study was performed between psychiatrists and OH physicians. The hypothesis was that psychiatrists might use the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (DSM-IV) more than OH physicians when reporting mental ill health. However, results have shown a considerable agreement between the two specialties. Nevertheless, in contrast to the concurrence between diagnoses made by psychiatrists and OH physicians, some differences were found in whether they considered the cases to be work-related or not. Surprisingly, psychiatrists were more likely to consider a case work-related than OH physicians, which may reflect differences in their day-to-day work, training or experience. As psychiatrists are less likely to deal with work-related ill health throughout their day-to-day tasks, presentation of vignettes of 'possible' work-related ill health may have encouraged them to consider the vignettes to be work related.

Another example was a study that compared criteria used by rheumatologists and OH physicians to determine that a condition was work related, showing that these two groups of medical specialists coded most items the same way, except 'symptoms in other workers'. OH physicians focused on the presence of similar symptoms in co-workers when determining whether or not something was work-related, whereas rheumatologists limited information to the person with health complaints only. These data contributed to a better understanding of how physicians handle diagnostic information.

Occasionally, some **industries and SMEs were interested in obtaining some specific data** gathered by THOR. For example, an energy-generating company requested information on reported dermatitis, musculoskeletal disorders and other conditions of their workers so that they could benchmark these data against the whole sector and gain a better insight into potential preventive measures that should be taken.

- **Stakeholders' views**

Drivers and obstacles

Drivers	Obstacles
The motivation and engagement of the reporting physicians. They take part in any potential changes within the system; for instance, they are always consulted before any modifications are made to the reporting forms. Different kinds of feedback for reporting parties have been developed and implemented (for instance constant communication between reporting parties and data assessors, quarterly reports, annual meetings and the most recently implemented platform, EELAB, which provides learning opportunities and continuing professional development points). Stakeholder 2 (reporter): 'For someone who's been a core reporting party for many, many years, I get more out of THOR than I actually put in.'	Difficulties in keeping physicians engaged. They are mainly caused by time constraints, increasingly busy schedules and growing demands in clinical practice. An important step to cope with this obstacle is to simplify the reporting procedure as much as possible. People within the THOR network have developed different strategies to deal with this issue. Stakeholder 1 (owner): 'We just make sure that we do everything and we are always looking at new ways; for example, we are thinking about trying to develop a reporting application. Just ways to make the process as simple and quick as possible really.'

Drivers	Obstacles
	They also mentioned delegating the reporting task to nurses or a group leader who reports for several people as a possible way forward.
Collaboration with the HSE. The HSE is informed of the work performed by THOR on a regular basis and, vice versa, people working within the THOR network receive continuous input from the HSE regarding the specific OSH domains that they are interested in.	Government funding. THOR is currently partially funded by the HSE, whereas the OPRA and THOR-GP schemes receive no financial support. The decision of the current government on whether or not to provide the funding is closely linked to the level of importance that is given to OH and safety, and at the moment this does not seem to be a priority.
Stakeholder 3 (researcher): *'The more we can publish evaluation studies, as we have been doing, the more it means our projects are applied not simply to identifying problems, but also to showing what solutions work and what solutions don't. So for policy-makers, there may be more of an incentive if they feel that the money they're giving is helping them to understand the solutions rather than simply pointing out more problems and more risks.'* In addition, small peripheral projects targeting very specific areas of occupational safety and health, such as the one on the prediction of asthma hazards, provide additional opportunities for funding in those contexts.	

- **Quality of data**

All the stakeholders interviewed (owners, reporting parties and researchers) agreed on the excellent quality of the statistical analysis and reports that the system provides.

Stakeholder 2 (reporter): 'They're absolutely fantastic. Even with all the problems that we've talked about [lack of adequate exposure assessment, poor quality of the job description], I think the quality is really, really good. And certainly in my day-to-day work, I use it on a regular basis. And the first place I'd look to is the data that come from here. If I had a query or I thought there was a new case or something like that, that's the first place I'd look to.'

Another confirmation of the quality of the statistical data is the fact that the annual statistics produced by the THOR system have been deemed the national statistics by the UK Statistics Authority.

Stakeholder 1 (owner): 'I would say that we have used practically all the data … all the different variables that we collect on the form, in various research questions. There's probably no piece of information that we collect that we haven't used for something. Like we've obviously done a lot of general descriptive stuff by age and gender, but when working on a paper we also look specifically at instances related to age because of the older workers and all that sort of thing. Then obviously the occupation and age and industry data are used all the time.'

The main concern of interviewees in terms of data quality was the exposure assessment. Currently, physicians are obliged only to name the causal agent(s) while reporting, and exposure is not necessarily assessed as such.

Stakeholder 3 (researcher): 'The one thing that we're planning now is to try to get a higher level of exposure information. More about how long the exposure's been, or what steps have been taken to

quantify it and so on. And the other aspect that we want to get more information on is what does the physician do about it, how has the loop been closed, were steps taken then to reduce this, has this been taken up with management and so on. But if we do that, there is also the risk that people will then report less because they realise that if they start to report a case they have to provide all the extra information.' Some stakeholders also expressed their concerns regarding the quality of job description in reporting forms.

Stakeholder 2 (reporter): 'The problem is the quality of the job information. I think the data on that, the quality isn't good at all. Because we're just not asking the right questions. Well, we're not given the opportunity to put the detail in it. So a nurse is a nurse. A doctor is a doctor. But there's a big difference. There's a big different between nurses. Some nurses, healthcare assistants, they might be recorded as a nurse, but they're technically not nurse trained and yet they do the most dirty jobs; bathing the patient, cleaning the patient, etc. So they're more at risk. Whereas the ward manager, the sister, is more administrative, managerial, least at risk. But you need to make that distinction.'

- **Transferability to other countries**

Ireland (ROI) has implemented THOR ROI since 2005 and it includes SWORD, EPIDERM, OPRA and more recently GP. The Health and Safety Authority (HSA) in Ireland financially supports the University of Manchester in producing THOR ROI reports. The HSA values the quarterly and annual reports including the comparisons that can be made between Ireland, Great Britain and Northern Ireland. The HSA is currently working with the University of Manchester and the Faculty of Occupational Medicine of the Royal College of Physicians of Ireland to find ways of encouraging more active reporting by enrolled physicians and other physicians to enrol in the various schemes.

When discussing the possibility of transferring a monitoring system such as THOR to other countries, interviewees agreed it could be possible, but they also emphasised the importance of differing local conditions in countries. They pointed out some requirements and conditions for the implementation of a system similar to THOR, such as the motivation of physicians, researchers, the enforcing bodies, industries and other stakeholders and their attitude to owning such a system and contributing to it. Financial support is clearly another condition for establishing this kind of monitoring system.

3.2.5 RNV3P (France)

- **System's aim and objectives**

The National Network for Monitoring and Prevention of Occupational Diseases or *Réseau national de vigilance et de prévention des pathologies professionnelles* (RNV3P) is a network for monitoring and prevention in OH, grouping the 30 occupational disease consultation centres (CPPs) in mainland France and, from 2018, a new centre in Réunion Island.

This network aims to collect data from each medical examination of patients from each consultation centre into a permanent national database on ODs (patient's demographic data, diseases, exposures, business sector and profession). By collecting cases, the RNV3P database can act as a sentinel or alert system and is used for detecting new and emerging risks. The RNV3P network encourages dialogue between OH different stakeholders and aims to obtain knowledge regarding monitoring, detection and prevention.

Information on RNV3P is available at: https://www.anses.fr/en/content/rnv3p-national-network-monitoring-and-prevention-occupational-diseases

The main partners of the network are the French Agency for Food, Environmental and Occupational Health and Safety – *Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail* (ANSES) – which operates the RNV3P network, the health insurance bodies for workers (CNAM) and specificically for agricultural workers (MSA), the French Public Health Agency (Santé Publique

France) and the *Institut national de recherche et de sécurité* (INRS, French reference body for occupational risk prevention).

At regional level, each of the OD consultation centres had to make a specific agreement with the regional level of CNAM (CARSAT), which shares with them the aim of occupational health prevention.

- **Description of the system workflow**

Reporting parties

The reporting physicians of the RNV3P are physicians who are employed in the 30 OD consultation centres of France's teaching hospitals or *centres hospitaliers universitaires* (CHUs). Their main activity in relation to the RNV3P is assessing the work-relatedness of patients' diseases. Other consultation requests concern keeping workers in employment, assessing work capacity and fitness, or providing career guidance to employees (for example young people with asthma).

RNV3P reporting parties receive annual training to educate and motivate them. The focus of this training is to learn how to encode and enter qualitative data into the database. The interviewees mentioned that they also plan to develop online automated training or tutorials in the future. Until the time of writing, a computer engineer from the team of the University Hospital of Grenoble has been responsible for the education of newcomers. In the OD consultation centres, a 'buddy system' is applied. The senior physician coaches the junior residents and continuously validates or corrects their work and database entries. Background characteristics are coded and reported by administrative staff, whereas medical and other work-related data (such as disease, exposures, position and industry) are registered by the medical staff. Only data that are validated by a senior staff member are considered for inclusion in the database.

Reporting mechanisms

Most patients are referred to the OD centres by OH physicians who are employed in the local companies (60 % to 70 % of the referrals) and who request a disease diagnosis. About 15 % to 20 % of the referrals come from GPs, and medical specialists such as pulmonologists or rheumatologists. GPs mainly address occupational stress issues. Referrals regarding musculoskeletal disorders are becoming increasingly prevalent. In addition to GPs and medical specialists, medical advisors of the social security system also make use of the OD consultation centres' services to evaluate the work-relatedness of a disease.

First, patients are received by a secretary, who collects a certain amount of administrative data and background details such as date of birth, gender, address, treating physician, address of treating physician, current employer and so on. The reason for the consultation is also specified during the first interview. Possible reasons are an expert evaluation for the social security system, a WRD diagnosis or issues related to work capacity. Other possible topics of discussion or investigation may relate to forensic medicine, recognition of ODs, actions to keep workers in employment and so on. Subsequently, a physician further investigates the medical condition of the patient, exposures and the possible link between these. Information on each patient is available in his or her medical file, which is linked to the data that are entered into the RNV3P database. A trained physician enters the following data in the database: disease variables (ICD-10 codes), occupation using the International Standard Classification of Occupations, type of industry using the *Nomenclature d'activités française* and occupational exposures using a specific thesaurus that is developed in France. This thesaurus contains hierarchical codes that cover all types of exposure (chemicals, physical, biological, psychosocial) and explanations on how to use the codes. After quality control, a senior physician validates the data. Following the consultation, a report is sent to both the treating physician or OH physician and the patient.

Each report in the database can be linked with the corresponding medical file in the OD centre where the consultation was made. For this reason, it is possible to obtain further information on a case.

Work-relatedness evaluation

It is up to the network's university hospital experts to investigate the diseases and attribute them, if necessary, to an occupational origin (this 'expert' opinion on causality is also registered in the database).

The OH expert physician encodes the link between exposures, substances and medical conditions in the database, referred to as the degree of imputation. An association between disease and exposure, for example asthma and isocyanate, is scored on a scale from 'very likely' to 'impossible'. The degree of imputation is based on the types of exposures, their intensity, the chronology of symptoms and so on. A senior clinician always validates this score.

Communication

Communication between reporting parties, experts and researchers is continuous. Experts and researchers from the emergence working group, for instance, evaluate the degree of imputation that is attributed to a case by the reporting parties. They perform searches in and outside the database, execute data analyses and evaluate if other colleagues have reported similar cases. If they detect a signal and an alert is needed, they communicate this to the reporting parties and all the appropriate authorities.

Data storage

The RNV3P database has evolved over the years. The first database was located and managed by the CHU of Grenoble, which was then extended to all other French CHU occupational consultation centres. The CHU of Grenoble was responsible for collecting and merging all the registered data. Later (2007-2012), the system was transferred to the other CHU OH consultations across France. It then became a more global online information system containing the national database, accessible from anywhere. Today the system allows real-time data entries by the different consultation centres and actors. After validation by senior clinicians, updates are immediately available in the national database. The database is secure and protected. As with bank accounts, users need a token and a code to log in to the system.

▪ Dissemination of results

The network produces activity reports and scientific reports on a regular basis, every two or three years:

- 2016 activity report: https://www.anses.fr/fr/system/files/RNV3P-RA-2016.pdf;
- 2014 scientific report: Réseau national de vigilance et de prevention des pathologies professionnelles Méthodes de détection et d'expertise des suspicions de nouvelles pathologies professionnelles (« pathologies émergentes »), Avril 2014. Available at: https://www.anses.fr/fr/system/files/RNV3P-Ra-Avril2014.pdf.

The interviewees mentioned that they published articles in top-tier scientific journals such as *Occupational and Environmental Medicine*, or public health journals. They also presented abstracts at important international conferences.

▪ Financial aspects

The OD consultation centres do not carry out classic care consultations at the hospital. They are financed by two funds. The first funding source is called missions of general interest (MIG), managed by the *Direction générale de l'offre de soins* (DGOS) within the French Health Ministry. The DGOS distributes the funds across the different university hospitals. The RNV3P is a part of these missions of general interest. A second financial source is funding from the CNAM, through its regional levels (CARSATs). These OD consultations take more time than a classic consultation. The OH physician must question and investigate the employee thoroughly through several diagnostic tests and determine a link with the work situation for which a follow-up company investigation might be required. Subsequently, the physician must register and code the data in the RNV3P database. The convention allows the financing of staff such as a secretary and medical practitioners. Hence, the survival of this system is largely dependent on both sources of funding. The CNAM spends slightly over €1 million every year to finance the activities of the OD consultation centres, which is added to MIG funding by the DGOS from the Health Ministry (about €8 million). The overall allocation of the MIG varies and depends on the size of the consultation centres. The allocation can range from €50,000 to €400,000. An example of a large and important consultation centre is Créteil, which sees about 4,000 people each year.

ANSES, as the operator of RNV3P, covers all expenses related to the information system development and maintenance; gives a financial contribution to the centres for each new case recorded in the

database; covers all expenses related to the working groups, coding school and scientific committee (experts' mission expenses); covers the wages of the RNV3P coordination team based in ANSES (such as the IT expert, RNV3P project manager and statistician); and has specific research conventions (Conventions Recherche Développement).

- **Usage of data**

The RNV3P database is intended for vigilance and collects cases. The database does not aim to be a representative sample for France; the RNV3P database is more a vigilance database (like pharmacovigilance spontaneous notification systems) than a database dedicated to epidemiological studies (Bonneterre et al., 2008; Bonneterre et al., 2010).

Each physician at an OD centre is able to access the database at any time to look, for instance, for cases in other centres that are similar to those he or she is currently investigating. RNV3P partners can also make requests and get summarised information regarding their field of interest.

Examples of data usage for informing policy and prevention

At the company level, following the OD consultation, feedback is given to the company's OH physician regarding the identification of a specific occupational exposure that requires preventive actions. A recommendation to a company might be a risk evaluation or protecting the employee against an exposure.

When the RNV3P network brings to light a certain number of pathologies due to certain exposures, prevention in the regions and companies concerned becomes urgent. This also requires an alert to the Caisse Nationale de l'Assurance Maladie des Travailleurs Salariés (CNAMTS), the INRS and the *Direction générale du travail*, Ministry of Labour, to organise prevention and control at the national level. The agency can also use the data to suggest regulations about chemicals.

On a more macro level, the RNV3P network describes risk situations, for instance as part of the national cancer plan. The network was also later asked to describe risk situations concerning certain cancers in the context of work. A report and communications targeting occupational physicians were based on this work.

Another example was the detection of numerous allergies, such as allergic dermatoses and allergies to methylisothiazolinone (methylisothiazolinone has replaced parabens in a certain number of cosmetic formulations) among hairdressers, beauticians and so on. Hence, ANSES has suggested a measure under the European Union regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) to limit the use of methylisothiazolinone at the European level. France can thus be proactive and forbid this substance in cosmetics when it exceeds a certain concentration level.

Examples of data usage for detection of new/emerging WRDs

The RNV3P network is also used as a sentinel system for identifying new/emerging risks. Today, the alert system encompasses a specific process of three stages. The three steps are risk detection, evaluation and action. Detection can be clinical: clinicians can identify and report a case that seems to be emerging, and this case is then discussed at national level. Detection can also be performed using information from statistics such as data mining and disproportionality signals or from a bibliographical search (Bonneterre, 2012). Detection can even be proactive, by searching for cases in response to alerts on new diseases from other sources or organisations (literature, NIOSH, Modernet). Subsequently, the signal is further explored and evaluated by the expert working group based on an algorithm containing three dimensions, which subsequently leads to an emergence score. Experts calculate a score for imputation (range: 'very likely' to 'impossible'), seriousness of the case (range: 'not severe' to 'fatal') and the frequency of occurrence of similar cases in and outside the RNV3P database. This provides a final emergence score. The algorithm and scoring system have already been validated based on the literature and in previous RNV3P cases. Depending on the score produced by the algorithm, the emergence score, the experts from the emergence group decide whether it is necessary to trigger an alert at the national level, whether this case should be internally consolidated or it should be discussed with foreign peers. A level 1 alert involves notifying only RNV3P physicians and recommending that the risk to and protection of the worker be evaluated. A level 2 alert requires that other clinicians and other RNV3P partners be informed and a search for similar cases outside the RNV3P network be made. Level

3 means that large-scale dissemination through health surveillance agencies and actions is required. This means that, for prevention, the reporting and the alert can be made at the regional level; to institutions, sanitary security agencies or bodies that are partners at the national level, such as the INRS or Santé Publique France; or straight to the ministries of labour and of health. Another possibility is that ANSES takes the alert as a prompt to suggest regulatory changes.

On a case-by-case basis, the emergence working group sometimes highlights cases from the network, which are then subsequently redirected to the governing bodies. An example of a new case was a nail prosthetist who suffered from hypersensitivity pneumonia. The exposure in question was to ethylmethacrylate. Two cases of hypersensitivity pneumonia had already been described, but were linked to another exposure, to methyl methacrylate. A notification was sent to the physicians in and outside the RNV3P network. Wider dissemination would require a second similar case.

Another example concerns asthma patients working in the coffee machine maintenance industry. Two of these cases were detected in the database. Subsequently, the association between asthma and exposure to a certain mould (*Chrysonilia sitophila*) has been documented. The exposure was already known in other industries and jobs such as woodwork. Similar cases were also published at the same time in Spain and Italy. Hence, wide dissemination was required, which led to an alert within the sector in question. The industry has since exchanged information with ANSES to determine how to better protect it employees.

A third example relates to the occurrence of non-Hodgkin lymphoma (NHL) in welders using anti-splash sprays containing methylene chloride, also known as dichloromethane (DCM). Four independent cases were detected, but they concerned different subtypes of NHL. DCM had already been classified as a carcinogen by the International Agency for Research on Cancer, especially because of the risk of NHL. A level 2 measure was required, meaning that information was exchanged with other clinicians. Wider dissemination may be mandatory if the degree of imputation increases.

Examples of other usage of data

Some researchers have also analysed the geographical dimension of the RNV3P network. Using the geographical information system (GIS) they wanted to understand the spatial aspect of the RNV3P observations and of the related variables (patients' addresses, workplace addresses and the referring physician's address) (Delauney et al., 2015). The analyses have shown that, although the network covers the whole country, the density of observations decreased as distance from the 30 OD clinics (located in the main French cities) increased. Taking into account the underlying workforce, the study demonstrates large discrepancies in the probability of different OD clinics capturing an OD (assessed by rates of ODs per 10,000 workers). This capture rate might also show differences according to the disease (Delauney et al., 2016).

Based on the personal interests or research topics of researchers and experts, matrices are built to analyse possible associations between specific exposures, diseases, jobs, industries and so on. Some researchers, for instance, are interested in workers who suffer from systemic scleroderma and look specifically at those who have been exposed to silica and solvents. Others might be interested in specific jobs and industries and construct a job versus exposure matrix to determine how many workers have been exposed.

- **Stakeholders' views**

Drivers and obstacles

Drivers	Obstacles
The high quality of the data that are entered, guaranteed by appropriate training, which is given to all the different actors in the network and those who are involved in the standardisation, control and validation processes.	Maintaining the necessary resources and means. OD consultations require a large investment of time, as they often include a great deal of investigations and diagnostic tests. Entering the data into the database, validation by a senior clinician, administration and support are also time-consuming and generate large costs.

Drivers	Obstacles
The cooperation between all stakeholders, such as the physicians from the OD consultation centres, OH physicians who refer patients, the prevention actors who work in the companies and all the bodies that act on regulation or prevention at the national level following alerts. All these actors work together and are linked to each other, which of course necessitates constant, daily monitoring by the agency. Therefore, regular meetings are organised, which provides the opportunity to interact in real life, and to move the system forward. This network makes people such as risk prevention experts, physicians and other OH care workers work together. Stakeholder 1 (owner): 'So, distance means efforts and perseverance, and also maintaining the human link with people who are geographically far away, and the network needs leadership to stay vibrant and make everybody understand the sense the network gives to themselves and others, the mutual benefit, also in the true sense of the word.'	Stakeholder 1 (owner): 'Of course, for every consultation, to begin with, OD consultations are long, and on top of that we need people behind to enter the data into the database. And so that takes time, and then the senior validation, that takes time and means, both for administrative, support functions, and means in medical time.' OD consultations produce too little income for the hospital compared with other medical consultations and treatments, which charge per medical procedure. These financial concerns are important and often an issue of discussion with the Health Ministry, the DGOS and the CNAMTS to try to secure the daily operation of the consultation centres and of the network, and to guarantee their quality.
The upgrade to an online information system has helped the users a great deal, as the RNV3P database is continuously being used and is constantly changing. The system is also very responsive. New codes relating to new exposures or substance can be added. Stakeholder 2 (reporting party): 'That means that I am in charge of the emergence working group; if we identify new issues, we are going to say "well, caution, now, we have 3D printing, additive manufacturing, we have to be able to identify all the diseases that will occur, linked to these new types of exposures, these new types of use". But the issue is that with 3D printing you can use the methacrylates, you can use alloys of vanadium, titanium or whatever you want. So we won't find them by job, industry or exposure. So we need to be able to explain that the risk, for example exposure to titanium, will take place in additive manufacturing, so that we have the code added.'	The researcher and clinician mentioned that it is important to find a balance between asking reporting parties a lot of information and motivating physicians to continue to report cases. Stakeholder 2 (reporting party): 'That is so, but this is because we have to find the balance between wanting people to enter a lot of information, and it is more interesting afterwards when we analyse, and the fact that in real life you can't spend 25 minutes encoding every single consultation.'
International collaboration. The Modernet network provides the opportunity to be challenged by other experts in other areas. This network provides a forum in which to exchange ideas and pathologies.	

- **Quality of data**

Data that are encoded and registered by physicians are entered using a standard form, to enable comparisons between entries and standardisation. After the data are entered, several automatic quality controls begin. Major or minor points, or missing data, mean that the reporting party immediately receives an alert. If the alert concerns major points (for instance the type of industry is not entered), the data cannot be validated. To maintain a high quality of data registration, a senior clinician from the OD

consultation centre always validates the data. Non-validated data are registered, yet will not be integrated into the national database and will be considered unresolved. The interviewees claimed that the quality of the data improved over time.

Stakeholder 3 (researcher): 'It means we can have the best statistics methods in the world, and the best epidemiologists to answer a question, or subject matter experts – if the data are ever biased, or low-grade data, I want to say, no pattern can fix low-grade data so what comes in, well, what comes out is as important as what comes in.'

The database also contains a standardised live thesaurus of occupational exposures. The thesaurus includes high-quality coding of products and substances. There are discussions that the thesaurus should be shared at the national level and that there is a need for harmonisation at the European level. Yet building and maintaining a high-quality and standardised thesaurus takes a great deal of time and money. As new products that might have an impact on work life continuously emerge on the market, vigilance is needed. The update of the thesaurus and coding within the RNV3P database is a part of the strategic plan.

Stakeholder 2 (reporting party): 'A heightened level of vigilance and a culture of quality has still spread, I would say, without a doubt mainly since 2005.'

- **Transferability to other countries**

Some countries already have similar systems to that of the RNV3P network, and RNV3P is completely ready to exchange information with other countries, such as with the THOR system in the United Kingdom and in Ireland. Creating networks between countries will make it possible to organise OH data as a basis for prevention. The RNV3P network has a scientific advisory committee, which consists of three or four people from other countries from different disciplines, such as epidemiologists, statisticians and OH professionals. To consolidate the RNV3P strategy in the years to come, it is important that people who have a good knowledge of both this type of network and of OH look beyond the national boundaries. This is essential in terms of strategic priorities: activities should not only be internal but also with external parties and scientists.

3.2.6 EpiNano (France)

- **System's aim and objectives**

EpiNano aims to survey the mid- and long-term health effects on workers employed in the nanotechnology-related industry or research and development (R&D) facilities in France possibly related to occupational exposure to either carbon nanotubes (CNTs) or titanium dioxide (TiO_2) nanoparticles, aggregates and agglomerates. EpiNano consists of a registry of workers likely to be exposed to engineered nanomaterials (ENMs) and a prospective epidemiological cohort study.

In the past years, the handling of ENMs in industry has grown. Despite the burden of research there is a lack of data on the human health potential risks related to ENM exposure. In France, the French government officially charged the former *Institut de veille sanitaire* (InVS)[1], which is now part of Santé Publique France, with developing epidemiological surveillance of workers occupationally exposed to ENMs.

The French Registry of Workers Handling Engineered Nanomaterials (EpiNano) is designed by the OH department of the French Institute for Public Health Surveillance. It is a uniquely designed epidemiological surveillance system for workers likely to be exposed to ENMs. It is a prospective cohort to monitor medium- and long-term potential health effects of ENMs, and enables further research. The method and the tool (the on-site technical logbook) for exposure assessment were designed to be usable as part of the EpiNano programme of epidemiological surveillance of workers potentially exposed to nanomaterials in France.

[1] Although the InVS merged with other organisations into Santé Publique France, the name InVS is used in this section, which describes the development of EpiNano.

- **Description of the system workflow**

The surveillance plan was initially proposed on the basis of a literature review, discussions with national and international ENM and OSH experts, and a feasibility study on exposure assessment in eight companies producing or incorporating CNT, carbon black, TiO_2 or amorphous silica. The **feasibility study** distinguishes three types of companies working with nanomaterials:

1. R&D facilities producing and using emerging nano-objects such as CNT;
2. chemical companies that have already been producing nanomaterials for some time, such as amorphous silica, carbon black or TiO_2;
3. companies using nanomaterials.

The feasibility study studied the on-site investigations and technical visits to collect critical information such as the number of workers likely to be exposed to nanomaterials, the conditions of exposure, medical follow-up and collaboration issues.

Subsequently, it was decided to have a double epidemiological surveillance design, which consisted of a prospective cohort study and repeated cross-sectional studies in which the two parts of the surveillance system complemented each other. Because of the costs of the prospective follow-up, the cohort was limited to CNT or nanoscale TiO_2.

The current plan is based on a multistep methodology in which **exposure registry construction** is paramount. The first step was to set up an exposure registry, which keeps a record of workers using or handling powder from nano-objects at the workplace. Workers potentially exposed to CNT or TiO_2 are identified using a three-level approach:

1. identification and selection of companies linked with ENM exposure (based on compulsory declaration and questionnaires);
2. on-site exposure assessment and identification of the jobs/tasks involving ENM exposure (based on job-exposure matrix, further supplemented with measurements);
3. identification of workers concerned; data of interest to be collected by questionnaire.

Developing this exposure registry required identifying companies concerned with nano-objects, gaining management cooperation, defining inclusion criteria, addressing issues related to personal confidentiality, enrolling workers and collecting exposure data. Exposure was assessed qualitatively or semi-quantitatively (job title, work tasks, duration of employment and so on).

Subsequently an additional non-specific health follow-up was developed for workers registered in the exposure registry who agreed to inclusion in the prospective cohort. For passive health follow-up, medical records collected for administrative purposes are gathered, which includes data from health insurance organisations (such as doctor's consultations, drug deliveries and costly chronic diseases) and from hospitals (mainly medical diagnosis following hospital discharge). Medical data recorded on a regular basis by OH physicians are also collected. Active health follow-up is in the form of an annual self-administered questionnaire. Beyond the collection of health data, the annual self-administered questionnaire is useful for updating workers' contact details, so that they can be contacted and feedback be forwarded to them. Subsequently, optional modules can be implemented, such as standardised clinical examinations, diagnostic testing and a biobank for research purposes. Implementation of these modules depends on identifying hypotheses about serious health effects, critical information arising from the exposure registry and the availability of economic resources.

Reporting parties

There are no active reporting parties in the EpiNano approach. EpiNano researchers (epidemiologists and industrial hygienists) collect and analyse data in companies eligible for inclusion in the project.

Reporting mechanisms

EpiNano researchers collect and analyse data gathered through several steps:

1. identification of companies dealing with CNT and TiO_2 (by means of the declaration of nanomaterials that they send to ANSES);
2. sending out a company questionnaire;

3. site visit by epidemiologist and industrial hygienist, who determine, without measurement, workstations concerned with ENMs to identify workers potentially exposed to ENMs;
4. sending out individual questionnaire and inclusion in the cohort.

Exposure assessment by site visit

The Quintet ExpoNano working group, which consists of national experts from leading French institutes (the InVS, the INRS, the Atomic Energy Commission, the French Institute for Industrial Safety and Environmental Protection and the University of Bordeaux Segalen) and is specialised in nanoparticle metrology, industrial hygiene, occupational medicine and epidemiology, reviewed the available methods and developed a system for the exposure assessment by site visit. The method consists of identifying the workrooms and activities that involve ENMs in each company in order to identify the workstations that possibly cause exposure and assessing this potential exposure semi-quantitatively. The EpiNano team (epidemiologists and industrial hygienists) visit the plant for a technical inspection, interviews with workroom supervisors and observations of the activity at each workstation. The standardisation and data collection tool for the site visit is referred to as the on-site technical logbook; this book is filled in during the site visit with the help of all the people concerned – HSE managers, workshop managers, workers and so on – and is based on detailed observation (or explanation) of tasks and working conditions. The logbook was validated through an inter-method validation study (results conform to the method of reference) and intra-method reliability study (reproducibility of results between evaluators) and is available in French and English. The ultimate goal is the classification of the workstation as potentially exposed or not potentially exposed to ENMs, the number of workers potentially exposed and their job titles.

The site visit and data collection is organised on three levels:

1. company level: activity, process description, map, localisation of workrooms, available health and safety data;
2. workroom level: dimensions, air flow, efficacy of the ventilation system, local maintenance, staff and workstations, potential sources of ultra-fine particle emissions (background aerosols);
3. workstation level: processes used, whether or not it is enclosed, equipment; details regarding incoming and outgoing products; the presence of collective protection, individual protective equipment; operation of the workstation, quantity of products handled per operation, and the frequency and duration of operations.

A short questionnaire is sent to the company's OSH manager prior to the site visit, to gather all potentially useful documents (the plant's blueprints, certificates of inspection and maintenance of the collective protective equipment, annual declaration reports and supplementary materials such as nanomaterial characterisation data and results of the exposure measurement campaigns) to be consulted.

A site visit generally takes place over one or two days. It begins with the exchange of information about the EpiNano project (objectives, procedures) and about the company (its activities and work processes) between EpiNano researchers and representatives of the company in a conference room. The discussion enables the filling in of the first part of the on-site technical logbook, on the company's activities and the processes implemented. This discussion is followed by a study of the plant's blueprints to locate the circulation of materials in the premises and thus identify the workrooms in which nanomaterials are present. The technical inspection, in the strict sense of the term, involves visiting workrooms and observing the workstations and real activity. This step enables the description of the use of nanomaterials in detail. During the inspection, the EpiNano team members (two or three people, including at least one industrial hygienist and one epidemiologist) must be accompanied by the plant's person responsible for health and safety, the laboratory or department director and the OH physician. During the inspection, the second and third parts of the on-site technical logbook are completed, in order to identify the workstations possibly causing exposure and to further assess the potential exposure. After the inspection, verification and data entry of the information in the logbook, the company receives an inspection report. This report includes the conclusions of the workstation evaluations and a list of the workstations that potentially cause exposure to nanomaterials, aggregates and agglomerates. A copy of the computerised data from the logbook is attached to the report.

Identification of workers involved in jobs and tasks performed in workstations identified as exposed to engineered nanomaterials and invited onto the programme

The EpiNano system identifies the exposed workstations, regardless of the use of personal protective equipment. Workstations in which a worker may experience direct contact with an ENM (including aggregates and agglomerates) potentially by inhalation or cutaneous contact are classified as workstations linked with exposure. The information regarding personal protective equipment, the amount of ENMs handled during an operation, as well as the frequency and duration of handling is gathered from the workers' individual EpiNano inclusion questionnaires. This information is accounted for in workers' individual exposure scores for those involved in workstations identified as linked with exposure to ENMs.

Prospective cohort study and identification of health outcomes that require follow-up

In France, occupational medical surveillance is mandatory for all workers by law (French Labour Code, Articles R4624-10 to R4624-20). Like all other workers, those producing or handling nanomaterials also have a health follow-up, which is not specific to their exposure to nanomaterials but rather determined by their exposure to other substances.

The absence of a strong hypothesis about the potential risks to human health from exposure to nanomaterials and the numerous uncertainties inherent to the project lead to a pragmatic approach and the suggestion of a simple but evolving initial monitoring system. Health monitoring will focus on respiratory and cardiovascular effects, but retain a generalist character, corresponding to a vision of epidemiological surveillance. The cohort will also serve as an infrastructure, facilitating the establishment of ad hoc studies exploring specific research hypotheses, such as research and validation of biological indicators of exposure and/or early effects or cross-sectional or case-control studies on a particular pathology or health event.

In the summer of 2017 twenty-three companies have been recruited and visited in the EpiNano programme. Workstations in public research laboratories were more often classified as concerned with nanoparticle exposure and were less often equipped with personal and collective protection devices than those in the private companies visited. In total, 156 eligible workers have been identified, 94 % of which were included in the programme for epidemiologic 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 incidence (Agence régionale de santé, 1996). Moreover, 40 % of this cohort is subject to active surveillance of (yearly) exposure and to health follow-up questionnaires.

At the end of 2017, the data from the EpiNano cohort will be matched with data from the national health insurance database and national causes of death registry to study incidence and mortality with respect to nanoparticles exposure. Meanwhile, an effort is being made to encourage companies' participation and increase the number of workers involved in the programme.

Work-relatedness evaluation

No work-relatedness evaluation is performed since until now there has been no reporting of specific health problems related to nanoparticle exposure.

Communication

Within the participating companies there is a close collaboration between the EpiNano team and the employees of the company both in exposure assessment and in collecting information on health effects.

Data storage

No information is available on the way data are stored.

- **Dissemination of results**

EpiNano publishes an annual short report to companies, workers and the French ministries of health and labour, and scientific abstracts and articles. Further dissemination is through articles in journals of relevant professional societies, quarterly newsletters and brochures.

An example is the outcome of the feasibility study:

The EpiNano team visited eight companies between January and May 2014. The workplaces visited had 6 workrooms on average (ranging from 1 to 13), and 2 workstations per workroom (from 1 to 4). The mean number of workstations in which CNTs or TiO_2 nanoparticles, or aggregates or agglomerates of them, were possibly handled was around 8, depending on company activity, with up to 27 workstations in the largest industrial workplace. In total, 53 workstations were observed and the on-site technical logbooks were completed. Of these workstations, 25 (47 %) were in private companies and 28 (53 %) in public workplaces, mostly academic R&D laboratories.

CNTs were the most frequently handled material (43 workstations), with single-wall CNTs in 16 workstations (30 %) and multiwall CNTs in 27 (51 %). TiO_2 was handled in 5 workstations (9.4 %), and multiple types of ENM were handled in 18 workstations (34 %).

Overall, 30 workstations (57 %) were classified as linked with exposure to either CNT or TiO_2. Figures 2and 3 present the types of operations and tasks performed in the workstations observed and in workstations classified as linked with exposure to ENMs. Among the parameters assessed during the site visits, dustiness and humidity of ENMs seem to be the most important determinants of possible exposure in a workstation.

Figure 2. Distribution of workstations according to the type of operation performed: all workstations observed between January and May 2014 (*n* = 53). Source: Guseva Canu et al. (2015)

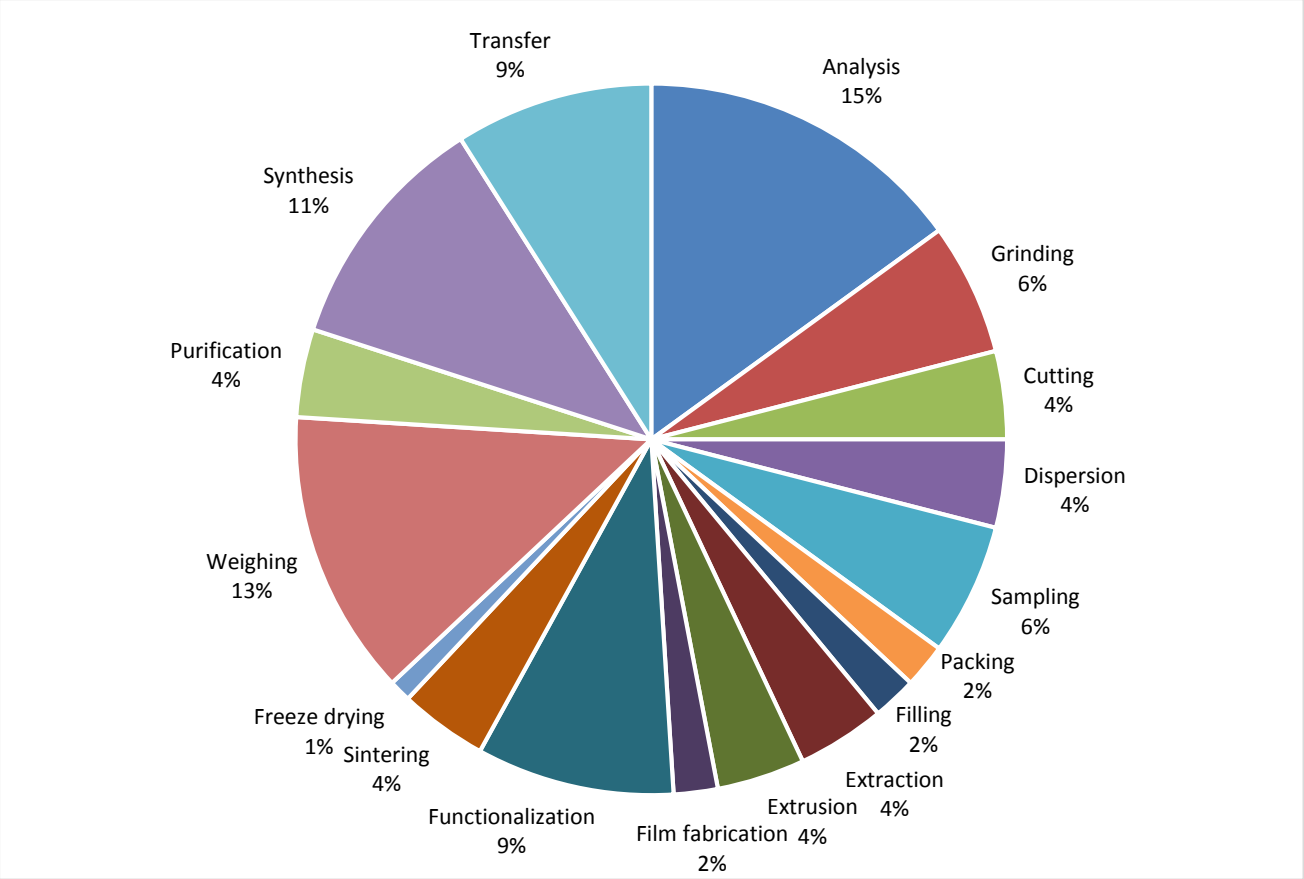
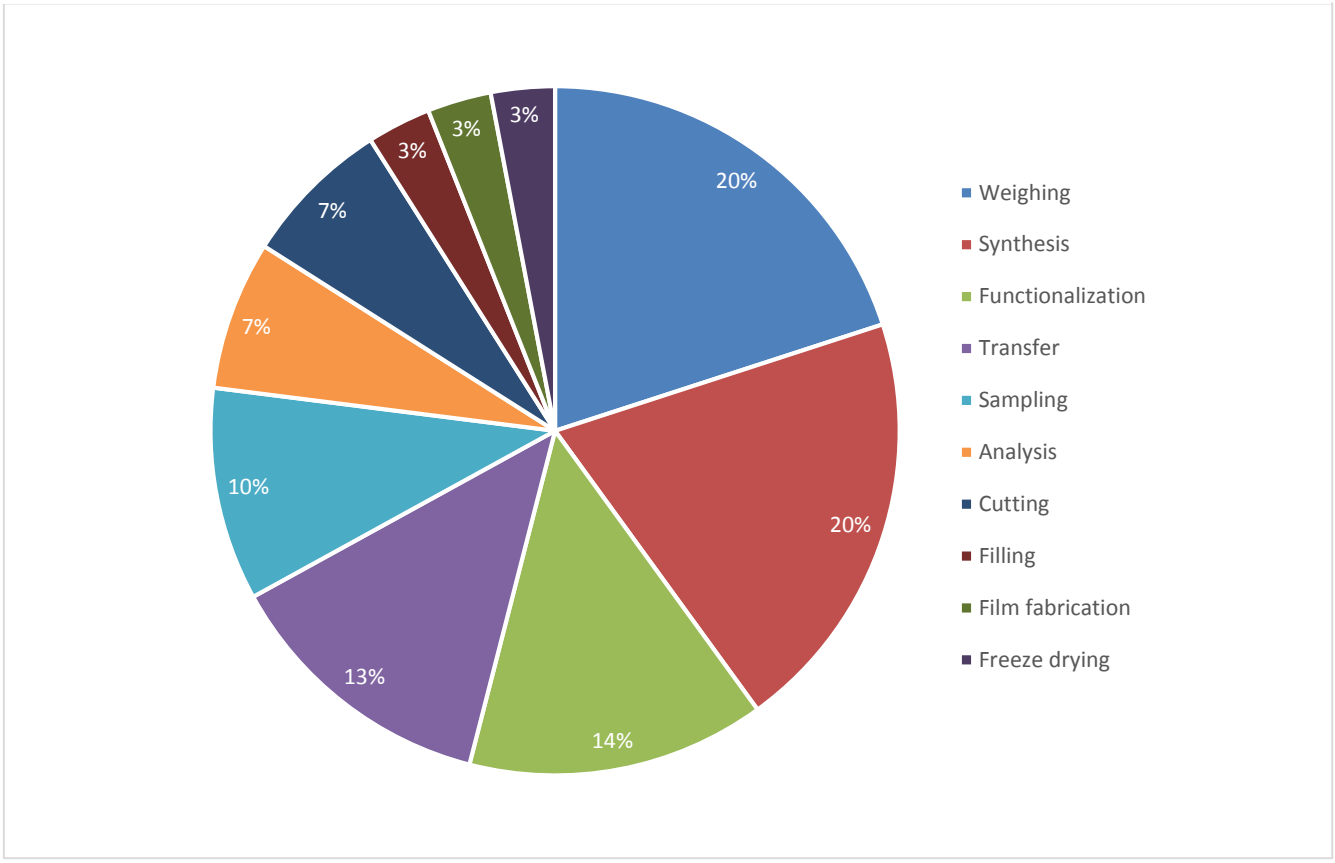


Figure 3. Distribution of workstations according to the type of operation performed: workstations classified as inked with exposure to carbon nanotubes or TiO_2 nanoparticles, aggregates and agglomerates (n = 30). Source: Guseva Canu et al. (2015)



- **Financial aspects**

No information is available on financial aspects.

- **Usage of data**

Examples of data usage for informing policy and prevention

No specific examples of data use for informing policy and prevention are available.

Although there is no consensus on the appropriate exposure measures to be assessed in individual exposure measurement in ENM-exposed workers, the International Organization for Standardization recommends the use of the control banding approach at workplaces that deal with ENMs (ISO, 2014). The European Commission published a guidance on the protection of the health and safety of workers from the potential risks related to nanomaterials at work (European Commission, 2013b) and EU-OSHA published an overview of tools for the management of nanomaterials in the workplace and prevention measures (EU-OSHA, 2013).

Several control banding tools have been proposed specifically for ENMs and the on-site technical logbook contains all the essential parameters for implementing any of these tools for assessing exposure bands at workplaces. They can be used directly by companies for risk management proposes, such as implementing the control banding approach to assess and control exposure to ENMs in different workstations. Consequently, the method may be straightforward and helpful for both exposure characterisation and risk management, which might be further improved with more accurate and quantitative exposure measurement data.

Examples of data usage for detection of new/emerging WRDs

There are no specific examples of data use for detecting new/emerging risks available.

The EpiNano programme is expected to be suitable for detecting new/emerging health risks from nanomaterials, since it has been developed specifically for this purpose. Until now, it has detected no new/emerging health risks, partly because health effects such as respiratory and cardiovascular conditions or cancer may develop only after chronic exposure and with a long latency and the surveillance system is too recent to capture them.

3.3 Sentinel systems

Eleven sentinel systems were studied in the Task 1 literature review (EU-OSHA, 2017) and their main characteristics are given in Table 10. Sentinel systems are built on principles of sentinel surveillance. This means that each reported case is seen as a warning signal and prompts investigation and necessary health interventions and preventive actions. Unlike the previous groups of systems, which aim to collect data from as many reporting parties as possible, sentinel systems use a limited network of carefully selected reporting sites. The systems identified in this group are implemented in only a few EU countries (Belgium, the Netherlands, France) and in the USA and New Zealand. They are mostly maintained by specialised research organisations (occupational and environmental health institutes or institutes for public health surveillance).

Of these systems, some target all work-related and/or occupational diseases, whereas others focus on a specific group of diseases, for instance WRDs linked with exposure to pesticides. In addition, most of the systems in this group are designed **with the aim of identifying new/emerging work-related health problems**. So, unlike non-compensation-related systems for data collection and statistics, which provide a wider picture of work-related health problems, sentinel systems are really focusing on individual cases which are potential warning signals of a health risk that should be addressed. Therefore, the data flow in these systems is adapted to this purpose.

The reporting of cases is based on the voluntary participation of reporting parties, mainly OH physicians. In some systems, other professionals, such as OH nurses and GPs, may also report. In three systems, employers or workers can report a work-related health complaint: Groupe d'Alerte en Santé Travail (GAST) in France, the Notifiable Occupational Disease System (NODS) in New Zealand and the Health Hazard Evaluation (HHE) system in the USA. As regards data collection, these systems are characterised by **more detailed exposure assessment** than in the non-compensation-related systems from section 3.2, which includes a more thorough description while reporting and possible workplace inspection with data gathering. This is one of the main strong points of sentinel systems in terms of monitoring new/emerging WRDs. However, sentinel systems usually have a narrower scope and a smaller number of reported cases, due to their focus on new or unusual work-related health problems. Therefore, it is necessary to carefully balance exposure assessment requirements so that the necessary minimum of information for work-relatedness evaluation is provided, but also the risk of reporting fatigue is not exceeded.

Another important common feature of these systems is a **'low-threshold' approach to reporting**. This means that reporting to systems is not limited by a strict definition in reportable conditions, but even unclear health complaints without a definite diagnosis can be reported and assessed. This obviously increases the sensitivity of these systems and creates chances of timely detection of previously unknown work-related risks and diseases. 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 appropriate expert evaluation of work-relatedness could be an efficient method for the early detection of new/emerging WRDs.

Indeed, in these systems work-relatedness is evaluated with a high level of expertise, which in most of them includes a team of experts on new/emerging WRDs. In two systems (SIGNAAL and OccWatch),

work-relatedness evaluation involves a **discussion between experts from different countries**. For instance, the system called Occupational Diseases Sentinel Clinical Watch System (OccWatch) was created by specialists from different countries participating in the Modernet network (Modernet currently involves experts from 18 European countries: the United Kingdom, the Netherlands, France, Italy, Finland, Czechia, Norway, Iceland, Ireland, Belgium, Germany, Switzerland, Spain, Croatia, Romania, the former Yugoslav Republic of Macedonia, Albania, Malta). This system provides an international online platform where experts from Modernet countries can comment on reported cases, or add similar examples from their own countries. The goal is an international exchange of knowledge on new/emerging work-related health risks and diseases. The interviewees and workshop participants pointed out the contribution of the Modernet network in facilitating this kind of international collaboration. They also agreed that the Modernet network should be broadened and the exchange of experience across borders encouraged in order to learn from each other and harmonise the existing approaches towards monitoring new WRDs in different countries.

After the work-relatedness assessment has been performed, the outcomes are disseminated and linked to workplace preventive actions. **A direct link with prevention** is one of the main strengths of these systems. However, unlike in the other groups of systems previously described, preventive actions implemented in sentinel systems involve direct investigation of the working situation from which the signal emerged, determination of risk factors and advice for implementation of preventive actions at the workplace. These preventive actions include a wide range of activities, such as direct workplace interventions aimed at co-workers or at workplace causes, and various forms of primary prevention (guidance regarding exposure or health surveillance, exposure reduction or substitution) and secondary prevention (increased medical surveillance, implementation of additional protective measures, modification of work tasks).

During the expert workshop, a big part of the discussion involved the issue of **different levels of alerts** depending on the sensitivity and specificity of a signal. Stakeholders supported the approach whereby systems produce graded levels of alert: level 1 would be derived from data which are not specific enough yet and therefore should stay within a limited group of internal experts; level 2 would be triggered when the signal becomes more specific (after the investigation and work-relatedness evaluation performed by experts) and target a broader group of experts; and finally level 3 would include wide dissemination at national level, involving different actors and preventive actions. This approach has already been implemented in some of the systems described in the report (for example the French RNV3P). Therefore, it can be implemented in sentinel systems, but also in other types of system, in order to add a sentinel aspect and help balance the sensitivity and specificity of alert signals produced by the system. This could be of particular importance in the systems with a wide scope and a large number of reported cases (such as non-compensation-based systems for data collection and statistics).

In the next sections, examples of sentinel systems implemented in different countries will be described in depth. This includes two European systems: SIGNAAL, a system implemented in Belgium and the Netherlands, and the French system GAST (Occupational Health Warning Groups). In addition, two other systems are described, both implemented in the USA: NIOSH HHE and SENSOR-Pesticides, the latter aimed specifically at monitoring health risks linked to pesticide exposure.

Table 10. Main characteristics of sentinel systems described in the literature review

Country (start date)	System	Organisation maintaining the system	Methods of data collection	Exposure assessment	Work-relatedness evaluation	Follow-up of new/emerging risks (yes/no); usage of data for dissemination/prevention
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)	Reporting by physicians	No record	Experts from state surveillance centres (staff epidemiologists, statisticians and other OH professionals)	Yes; dissemination through case reports, publications, guidelines for practitioners, actions directed towards co-workers and specific workplace causes
USA (1971)	NIOSH Health Hazard Evaluation (HHE) Program	NIOSH	Reporting by employers, employees or employee representatives	Assessed through workplace inspections carried out by multidisciplinary teams	Multidisciplinary teams carry out workplace inspections	Yes; results of HHE field evaluations are published on NIOSH website, recommendations are provided in HHE reports
Belgium and the Netherlands (2013)	SIGNAAL	Netherlands Center for Occupational Diseases and Centre for Environment and Health of the Catholic University of Leuven	Voluntary reporting by OH physicians, respiratory physicians and GPs	Described by reporter; additional assessment occasionally in follow-up research	Researchers of SIGNAAL employed at the Netherlands Center for Occupational Diseases and the Catholic University of Leuven	Yes; dissemination through international papers/symposium reports, website, possible preventive actions
France* (2013)	Occupational Diseases Sentinel Clinical Watch System (OccWatch)	Modernet (Monitoring Occupational Diseases and tracing New and Emerging Risks in a NETwork), coordinated by the French Anses	Voluntary reporting by occupational physician/specialists from Modernet	Described by reporter	Modernet; international network of specialists	Yes; possible dissemination to institutions concerned, online case-report database, each participating country responsible for linking with prevention

Country (start date)	System	Organisation maintaining the system	Methods of data collection	Exposure assessment	Work-relatedness evaluation	Follow-up of new/emerging risks (yes/no); usage of data for dissemination/prevention
France (2008)	Occupational Health Warning Groups (GAST)	French Institute for Public Health Surveillance (InVS)	Voluntary reporting by OH physicians (80 %), workers, unions, managers, medical specialists, GPs, industrial hygienists and others	Exposure is described increasingly precisely in each phase of the investigation	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 to reporter, occupational physician, enterprise manager and health and safety committee, online publication of report, primary and secondary prevention
New Zealand (1992)	Notifiable Occupational Disease System (NODS)	WorkSafe New Zealand	Voluntary reporting by physicians, OH nurses, employees and employers	Workplace inspections carried out if necessary	Investigating team consisting of OSH specialists conducts investigation, after which department medical practitioner from team makes decision; specialist panels consulted when necessary	Follow-up of cases referred to specialist panels; dissemination through reports, possible preventive workplace interventions
New Zealand	Cancer Panel (NODS)	Department of Labour (DoL)	Reviews all cases of selected cancer sites reported to New Zealand Cancer Registry as well as cases notified to OSH	Workplace inspections carried out if necessary	Experts from Cancer Panel	Yes; dissemination through case reports, studies, workplace preventive interventions
New Zealand (2001)	Respiratory Diseases Panel (NODS)	WorkSafe New Zealand	Reviews all cases reported to NODS, and cases from Asbestos Disease Register and	Workplace inspections carried out if necessary	Experts from Respiratory Panel	Yes; dissemination through case reports, studies, workplace preventive interventions

Country (start date)	System	Organisation maintaining the system	Methods of data collection	Exposure assessment	Work-relatedness evaluation	Follow-up of new/emerging risks (yes/no); usage of data for dissemination/prevention
			Asbestos Exposure Register			
New Zealand	Solvent Panel (NODS)	DoL	Reviews all reported cases related to solvent exposure	Workplace inspections carried out if necessary	Experts from Solvent Panel	Yes; dissemination through case studies presented internationally, workplace preventive interventions
New Zealand	Chemical Panel (NODS)	DoL	Reviews all reported cases related to chemical exposure	Workplace inspections carried out if necessary	Experts from Chemical Panel	Yes; dissemination through case studies presented internationally, workplace preventive interventions
USA (1987)	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	Reporting by physicians	No record	Experts' evaluation	Yes; no record

3.3.1 SIGNAAL (Netherlands and Belgium)

- **System's aim and objectives**

The SIGNAAL reporting system is an online non-compensation-based sentinel system. It has been in place since July 2013. SIGNAAL is the result of cooperation between the Netherlands Center for Occupational Diseases (NCvB), the Centre of Environment and Health at the Catholic University of Leuven (Belgium) and IDEWE (a Belgian external service for prevention and protection at work).

The main goal of SIGNAAL is to detect new OH risks and new ODs or WRDs. Before the development of SIGNAAL, the Netherlands and Belgium had no specific system for detecting, reporting and registering new ODs. Consequently, determining if the cause of a disease was work-related could take a long time. The initiators of SIGNAAL developed the system as an online tool. It would help collect information in a practical, quick and easy way, but at the same time provide enough information to be able to draw conclusions about a reported case. One of the strong points of SIGNAAL is that every reported case is evaluated in a structured manner by at least two independent OH experts. The experts assess if the case could be a WRD or OD and if it is a new OH problem. After the assessment, the reporting physician receives an expanded report. This report states whether or not the SIGNAAL experts consider the case is work-related and whether or not it is new. Consequently, it can be used by Belgian and Dutch physicians to submit a disease into the open system. Furthermore, this report contains supportive literary research, states the relevance of the disease to the job in question, and suggests the next steps in the course of action.

- **Description of the system workflow**

Reporting parties need to register and log in to the system to be able to submit their report. Reports of both individual cases and cases concerning more than one worker can be submitted. A great deal of information can be entered into the system: demographics of the worker or workers such as age and sex, but no other personal details; description of complaints; disease progresses; and preferably clinical diagnoses, job, sector, task descriptions, relevant exposure data, results of diagnostic testing and actions already taken. Some information is required, but there are also several open fields into which reporting parties can insert as much text as they want. A reporting party can also submit documents (such as pictures of a skin lesion).

Reporting parties

SIGNAAL is an online platform. Reporting parties who want to report on a new OH risk or a new OD first have to register on the website www.signaal.info (Netherlands) or www.mysignal.be (Belgium). A person who wants to report a case needs to register first, give his or her title and enter his or her contact details. After this the moderator of SIGNAAL can give this person access to the system so that he or she can report a case. So everyone whose registration on the website is accepted by the moderator can submit a report through SIGNAAL, although the system is primarily meant for physicians and only medically trained personnel can easily access the information required by SIGNAAL. Reporting parties must be able to diagnose a possible OD or WRD and to provide information on the workplace and exposure to occupational risks. Currently, almost all reporting parties are OH physicians. So far, only one other physician, a dermatologist, has reported a case.

Recruitment of reporting physicians

In the Netherlands, SIGNAAL is promoted to all OH physicians through scientific publications and various conferences. In Belgium, IDEWE informs OH physicians of the system, and tells them that SIGNAAL might help them prepare a file for the Federal Agency for Occupational Risks (FEDRIS) so that the worker can receive compensation (as previously mentioned, the reporting physician must show causality between exposure and OD). Although SIGNAAL is currently not actively promoted to OH physicians other than by IDEWE, several OH physicians working elsewhere have also reported cases.

In 2017, SIGNAAL was introduced nationwide in Belgium with the support of FEDRIS. FEDRIS has the task of detecting new ODs, and supporting the SIGNAAL system aims to contribute to better detection

of new occupational risks. On 31 March 2017, the Catholic University of Leuven and FEDRIS organised a symposium to inform OH physicians of SIGNAAL and to launch the system nationally.

Physicians who want to report a case can find all the relevant information on the system on the NCvB (www.beroepsziekten.nl) and SIGNAAL (www.signaal.info) websites. In Belgium, the system can be accessed on www.mysignal.be.

Work-relatedness evaluation

Once a case is reported in SIGNAAL, the moderator checks if additional information is needed. If essential information (for example relevant exposure data) is still missing, the reporting physician is contacted and asked for extra details. The system has a pool of several Dutch and Belgian OH experts who can evaluate the reported cases. When possible, every case is individually and independently judged by two different experts. The experts evaluate the reports in a structured way to assess if the case could be a work-related illness and if it is a new OH problem. A literature search is performed to find scientific evidence. Meetings between the experts are organised to discuss some cases. Since SIGNAAL began, the expert group has expanded.

Communication

As mentioned earlier, the administrator will contact the reporting physician if more information is needed. Exposure data, job description and diagnosis are not always described in detail. However, detailed information is essential in order to be able to make a good assessment.

After the experts have finished their evaluation, the reporting party receives an expanded report by email. This report contains supportive literary research, states the relevance of the disease to the job and suggests the next steps in the process. The experts may want to visit the workplace themselves. Sometimes, the reporting party wants to publish the reported case. This can lead to extensive collaboration between the experts and the reporting party.

Data storage

All the data are stored in a secured database. Only three people have access to the entire system. The experts have access to the cases they are working on and all steps of the review are entered into the system. Reporting physicians have access to only their own alert.

- **Dissemination of findings**
  - An annual report shows how many cases are handled by the researchers. The SIGNAAL website (www.signaal.info) gives a brief overview of finalised cases and the results of the evaluations (new or not, work-related or not).
  - Some cases have been published in peer-reviewed journals, for example by Francois et al. (2015) and Lenderink, Maleszka & Godderis (2016).
  - Some cases have been presented in conferences or conventions, for example at the 34e Congrès National de Médecine et Santé au Travail (Godderis & Lenderink, 2016).

- **Financial aspects**

The development cost of SIGNAAL are estimated to be about €175,000 (including pilot, evaluation and so on). The annual cost of reviewing cases in the last two years in the Netherlands was about €10,000 to €15,000 per case. The mean cost per case in the maintenance phase was calculated to be around €5,000.

- **Usage of data**

Examples of data usage for informing policy and prevention

At the end of every review, the researchers ask themselves what measures can be taken on the basis of their conclusion. Up to this point, the suggested measures have mainly been aimed at company level.

For example, in one company a 33-year-old woman developed **thrombosis of the right subclavian vein with pain in the right shoulder in extension and abduction** and power loss to activities at or

above shoulder height. She was an assembler and made window coverings (blinds, curtains). In the period preceding the illness she almost exclusively (20 hours per week) worked on sticking ribs to vertical slats. The weight she handled varied according to the length or the number of ribs. She handled the weights with her arm in external rotation, with abduction to about 60 degrees. Other possible causes for her health problems were that in addition to 20 hours of paid work per week she had two children, and she used to carry the youngest child. She smoked up to 10 cigarettes a day. Since the birth of her youngest child, she had returned to using oral contraceptives. An exploratory search in the literature for the causes of this disorder, the Paget-Schrötter disease, was performed, and findings pointed to the way in which the work was carried out. The fact that the thrombosis occurred in the subclavian vein and nowhere else in the body (in the lower legs combined with standing work, for example) suggests that there was an additional trigger, which could well have been the work. The literature contained some evidence of a link between the described exposure to repetitive work with the arm in abduction and external rotation and the origin of subclavian vein thrombosis. However, this was mainly described in sports and seldom found among workers. It was concluded that this was not an entirely new relationship between illness and work, but that it had not so far been described in this type of work. Organisational and technical measures facilitated job rotation and limited the length of the repetitive work (Dam, 2015).

Another example concerns **heart problems from carbon monoxide (CO) exposure at a coffee-processing plant**. A report was submitted about two employees who had worked for more than 25 years in a coffee-processing plant. They had both suffered from heart problems in recent years, which were classified as atypical. Only recently, it had been discovered that, in several departments of the plant where roasting and grinding of coffee is done, the CO levels could be very high. Although the company took immediate action to lower the exposure of workers to high CO levels, the reporting party asked if the atypical heart problems could have been related to previous high levels of exposure to CO. Based on the first measurements, the average CO exposure on a typical work day for both employees could have been just below or just above the exposure limit, 25 parts per million (ppm), for years. The literature had only two articles on coffee processing and carbon monoxide poisoning.

Based on the literature, it was concluded that chronic CO exposure increases the risk of cardiovascular disease for workers. CO affects both the availability of oxygen in the blood, which mainly affects the heart and brain and has a direct negative impact on the (heart) muscle. CO exposure is an additional risk factor to the heart, as well as the known risk factors such as high blood pressure, lack of exercise, smoking and high cholesterol. CO exposure can therefore contribute to the development of cardiovascular disease. It was also considered likely that CO poisoning often leads to atypical heart conditions. Both employees had suffered from heart problems in recent years, and at a relatively young age. Although in both cases other possible risk factors existed, it was concluded that it was certainly possible that exposure both to the moderate average CO exposure and to peak exposures during certain tasks could have contributed to the onset of their heart disease. The OH service started specific health surveillance, and a control system for exposure is currently in place.

In the Netherlands, policy-makers have been informed of a new risk that was detected in the SIGNAAL reporting system. Nosebleeds due to exposure to formaldehyde (and other aldehydes) in an aluminium company were described for the first time in SIGNAAL. The Netherlands National Institute for Public Health and the Environment (RIVM) wrote about this newly detected health risk in the report *Prioritization of new and emerging chemical risks for workers and follow-up actions* (Palmen et al., 2015). RIVM was asked by the Ministry of Social Affairs and Employment to make a priority list of the reported potential new and emerging risks of chemicals, with the intention of taking further action concerning the substances with the highest priority. RIVM classified formaldehyde as a substance with the highest priority (direct action required). Commissioned by the Ministry of Infrastructure and Environment, RIVM also carried out an inventory that shows that sufficient chemical alternatives are available for most disinfectants and preservatives (biocides) that contain formaldehyde (for instance for disinfection of stables and animal housing) (Wezenbeek et al. 2015). For some applications using formaldehyde, only a very limited number of alternatives are available (for instance preservatives used in lubricants and metalworking fluids).

Because of the limited number of reported cases so far (about 25 alerts in total), statistical analysis is not yet possible. The stakeholders hope that a larger number of reported cases in the future will lead to more useful advice for policy-makers concerning prevention.

Examples of data usage for detection of new/emerging WRDs

Until the time of writing, only one real new WRD has been detected by SIGNAAL: nosebleeds due to exposure to aldehydes in an aluminium company.

Other reported cases have been not real new ODs or WRDs, but ODs or WRDs that were already described in other work environments. For example, a 31-year-old man was hospitalised with respiratory symptoms and fever. He recovered rapidly after treatment with antibiotics. The man worked as a kitchen help and had cleaned the drain of the dishwasher using high pressure a couple of hours before his admission to hospital. The OH physician thought that this was a case of inhalation fever caused by the inhalation of aerosols during the cleaning of the drain. The literature review found several publications that described exposure to aerosolised endotoxins in other work environments (for example seaweed massages in a spa centre, biologically contaminated water pool in a building used for testing scientific equipment) that caused similar symptoms. The SIGNAAL researchers concluded that this was probably a case of inhalation fever caused by exposure to the endotoxin of the drain during high-pressure cleaning.

- **Stakeholders' views**

Drivers and obstacles

Drivers	Obstacles
System is easy to use for both reporting parties and assessors. Stakeholder 2 (reporter): 'It is basically an online platform … So that's actually relatively easy. There are no real major obstacles.'	Registration (before a physician can report) may be a possible barrier. Stakeholder 2 (reporter): 'Sometimes it can take up to a day before a reporting physician is admitted to the system.'
Cases are evaluated systematically by two different experts.	Evaluation of the reported cases can be time-consuming. Stakeholder 2 (reporter): 'I think it's important to get feedback faster as a reporter. … Or yes, because it takes a very long time before there is a final evaluation and you already forget about the report. So I think you can definitely improve this.'
Reporting parties receive an expanded assessment.	Physicians lack awareness about new and emerging risks. Stakeholder 2 (reporter): 'Sometimes there is a certain blindness to occupational exposure. You sometimes forget to look at occupational hazards.'
Personal contact between the system actors and thereporting physicians.	Physicians lack knowledge, mainly concerning exposure. Stakeholder 3 (researcher): 'You do need to know some things about exposure, and more often than not, that is not the case.'
	OH physicians today are overburdened. Stakeholder 3 (researcher): 'OH physicians have to do a lot of it in their spare time, and not everyone can be bothered doing that.'

While discussing possible thresholds of reporting in SIGNAAL, all stakeholders agreed that it is not easy to overcome these problems. The researchers need enough information in the system to be able to evaluate a case, but the reporting of cases must not be too demanding for the reporting physician. At present, reporting physicians already have to submit relatively large quantities of data, and increasing the data that need to be entered into the system may lead to less reporting. This is why one of the stakeholders suggests that the reporting parties submit just the mandatory data, and that the SIGNAAL researchers collect the rest.

Stakeholder 2 (reporter): 'If you could do the mandatory reporting in a very simple, accessible way by filling out an A4 page on the spot, and if you could put that A4 page online, then I think it would be even simpler, and the complete follow-up would be taken over by the system.'

- **Quality of data**

The researchers conclude that, overall, the **quality of the reported data** is sufficient to evaluate cases and form conclusions. The **quality of the case review** is also considered high. The fact that the evaluation is structured and performed by two different reviewers (experts in their field) contributes to the quality of the review, according to the stakeholders.

Stakeholder 1 (owner): 'The quality is good, in comparison with systems that are less structured because you are obliged to go over all the questions. And because you have two reviewers, you can compare the differences and have a discussion on how to form a conclusion.'

- **Transferability to other countries**

All stakeholders agree that SIGNAAL can be transferred to other countries. However, translating the system itself is not enough. A team of experts is needed to transfer SIGNAAL to other countries.

Stakeholder 1 (owner): 'You just need to have a team in that country that can deal with the alerts and has access to its own workplaces and doctors.'

3.3.2 GAST (France)

- **System's aim and objectives**

GAST – Groupes d'Alerte en Santé Travail, or Occupational Health Warning Groups, were initiated in 2008 to provide an epidemiologic response to unusual health events at workplaces and to alert of new/emerging work-related health risks and diseases.

GAST is maintained by Santé Publique France (former InVS[2]). GAST aims to assess reports from all sectors and all workplaces, including SMEs. As of 1 February 2017, GAST was implemented in 11 regions: Auvergne-Rhône-Alpes, Bretagne, Bourgogne-Franche-Comté, Centre-Val de Loire, Grand-Est, Hauts de France, Normandie, Nouvelle Aquitaine, Occitanie, Pays de la Loire and Corse. In the other regions, the signals are picked up by the regional InVS cell or *Cellule interrégionale d´épidémiologie* (CIRE) of Santé Publique France, with the help of an epidemiologist from the Direction Santé Travail of Santé Publique France.

GAST's mission is to provide an epidemiologic response to unusual health events at workplaces and to give alerts of new/emerging work-related health risks and diseases. This involves validating and evaluating reports of unusual health events at the workplace. The outcome of this evaluation is the decision on whether or not to carry out an investigation and to recommend actions to be implemented.

Any unusual health event occurring at the workplace must be reported to the Regional Health Watch and Emergency Platform of the Regional Health Agency (Agence Régionale de Santé – ARS). An unusual health event may be, for example, grouped cases of the same disease or the same symptoms

[2] Although the InVS merged with other organisations and became Santé Publique France, the name InVS is used in this section, as it describes the past development of GAST.

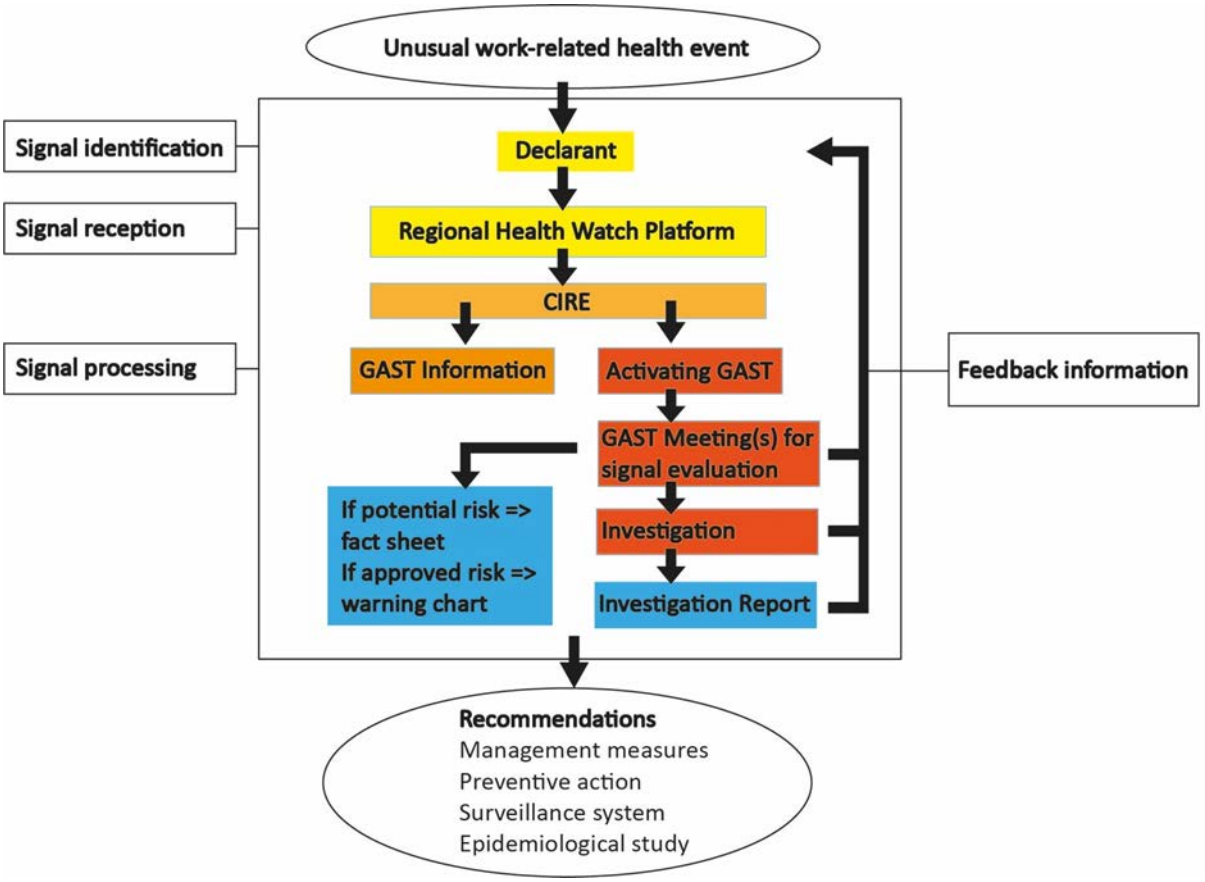
(possible cluster of, for instance, cancer or other disease); an excess number of deaths; or exposure to chemical, physical or biological agents that may have an impact on health.

- **Description of the system workflow**

The general workflow for reporting and assessing an unusual health event at the workplace through GAST is visualised in Figure 4. When an unusual health event occurs at the workplace, it is voluntarily reported to the regional health watch and emergencies platform within the ARS. This platform is a functional organisation of Santé Publique France (through the CIRE) and the ARS. It is responsible for the reception of reports reports, analysis, investigation and management of all events that may pose a risk to the health of the population. When the regional platform receives a signal in the field of health and work, it carries out a first validation and evaluation. If the signal appears unusual (for example grouped cases of cancer, poisoning, industrial accident), it directs the report to the CIRE. The latter mobilises GAST, which has a period of one month to validate the signal, to trigger an alert, to initiate an investigation if necessary and to decide, if necessary, on management and prevention measures.

During the investigation, the system collects data: depending on the problem reported, usually case information such as diagnosis or symptoms, but also a number of cases of occupational exposure, demographic information on the enterprise or public institution and information on exposure (described by the reporting party or assessed in addition). Each step of the work-relatedness investigation describes the exposure assessment increasingly precisely. In all cases, the reporting party is informed of the handling of the report both during and at the end of the investigation. GAST makes a decision based on the consensus of its members. It decides on the necessity of an epidemiological investigation.

Figure 4. Workflow of reporting and assessing an unusual work-related health event.



Source: Santé Publique France, 2016a

If an investigation is decided upon, it is coordinated by the CIRE in conjunction with the other members of GAST, after consultation with the OH physician and the head of the company. The investigative methodology can be based on the guide 'Epidemiological surveillance of mortality and investigation of spatio-temporal aggregates in companies' produced by the former InVS.

Based on the complementary skills and knowledge of the OH field of each of its members, GAST provides a coordinated, structured, unique and rapid response for its registrants. This system makes it possible to reinforce the health surveillance mission of the InVS and the ARS by bringing in the ad hoc local expertise in health-work relationships such as the Regional directorate for enterprise, competition, consumer affairs, labour and employment – Direction régionales des entreprises, de la concurrence, de la consommation, du travail et de l'emploi (Direccte) – or the Occupational Disease Consultation centres (CPPs) of the teaching hospitals (CHU). The results, including recommendations aimed at both primary (guidance concerning exposure or health surveillance, exposure reduction or substitution) and secondary prevention (finding the cause of a cluster to be occupational), are summarised in a final case report.

Reporting parties

The report can be made by any OH actor in charge of prevention or a witness of the event, for instance a member of a Health, Safety and Working Conditions Committee, the head of the company, an OH or other physician or a company employee. In practice, about 80 % of cases are reported by OH physicians, but cases have also been reported by health and safety committees, workers, unions, managers, medical specialists, GPs and industrial hygienists.

Work-relatedness evaluation

The regional GAST assesses the incoming reports. To mobilise multidisciplinary and complementary expertise, each GAST is made up of permanent members, who are specialists in OH risks and intervention epidemiology, and is coordinated by the CIRE. It includes:

- a medical labour inspector from the regional Direccte;
- a doctor from the CPP;
- an epidemiologist from the InVS health department;
- an epidemiologist from the CIRE concerned;
- possibly representatives of other bodies such as the Pension Insurance and Occupational Health Insurance, or the Poison Control and Toxicovigilance Centre.

Permanent GAST members are required to declare their possible conflicts of interest once a year in order to respect the principle of expertise independence.

Communication

Within the participating companies there is a close collaboration between the EpiNano team and the employees of the company in both exposure assessment and collecting information on health effects.

Data storage

The reports are collected in a database, Santé Publique France's national database of OH alerts.

▪ Dissemination of findings

GAST provides systematic feedback to the reporter, OH physician, enterprise manager, and health and safety committee by means of a final case report, which is also published on line (available at: http://invs.santepubliquefrance.fr/%20fr/Dossiers-thematiques/Travail-et-sante/Alertes-en-sante-travail/Bulletin-des-reseaux-de-surveillance).

The second bulltin reports on a quantitative and qualitative study was carried out in 2016 to learn more about the attitudes of OH physicians to unusual health events at the workplace, and to assess their knowledge of GAST (Dehmas, 2016). Between February and July 2016, 723 OH physicians practising

in metropolitan France were invited to complete an online questionnaire on their professional experiences with health alert networks. More than half of the responding OH physicians (394) reported that they knew to whom they could report the three types of unusual occupational events that were studied: a possible cluster of cancers or other serious illnesses, unexplained collective syndromes and unusual exposure to an atypical substance. On the other hand, 16 % of the OH physicians declared that they did not spontaneously know who to contact to report any of these three situations. The percentage of OH physicians who did not know differed significantly depending on the events: in the case of a possible cluster of cancers or other serious diseases, 28 %; in the case of an unexplained collective syndrome, 33 %; and in the case of exposure to an atypical substance, 28 %. The GAST tool was known by 146 doctors (20 %). Of the doctors surveyed, 37 % thought GAST had an alerting role, 29 % thought it collected data and assisted in the management of the event, and 18 % thought it had an investigating role. Fewer than 10 % of the OH physicians believed that GAST had an informative role. The percentage of doctors who did not know of its existence in their own region remained high (76 % in regions with a GAST). In total, 14 % believed that GAST is essential, 28 % found it necessary, 44 % thought it desirable and 1 % considered it useless. These first results point to the need for better communication about GAST to OH physicians.

- **Financial aspects**

No information is available on financial aspects.

- **Usage of data**

Examples of data usage for informing policy and prevention

Fungal contamination of local authority's departmental archives (Santé Publique France, 2016b)

In 2014, a local authority reported to the Regional Health Agency the presence of mould in the departmental archives, some of which presented a pathogenic risk for humans. GAST was asked about the health effects of exposure to these moulds. After analysing the dossier and consulting GAST, it was decided to identify the people who were sensitive to mould (either allergic or immuno-depressed) and check their workplaces for potential exposure to mould (maintenance, research and cleaning of documents in particular); inform employees of the potential effects and tell them to report any coughing, shortness of breath or fever outbreaks other than winter episodes; carry out cleaning to reduce dust, to recommend the use of FFP2 masks and only one type of gloves (vinyl); and systematically decontaminate the premises (walls, surfaces, shelves) housing the archives, the archival documents themselves and all other materials.

Suspicion of excess cancer cases in a research laboratory (Pilorget et al., 2017)

A suspected cluster of cancer among employees of a research laboratory was investigated by Santé Publique France and its CIRE in Rhône-Alpes, with the help of the medical prevention services concerned. For the nine cases reported, the investigation focused on identifying cases, the reproduction of the jobs and occupational exposures in the laboratory, a literature review of epidemiological characteristics for selected cancers, identification of known or suspected risk factors of these cancers, and research into carcinogenicity of used products and equipment. The analysis compared the occupational exposures with risk factors for identified cancers.

The seven cases selected for analysis involved seven different types of cancer diagnosed between 2001 and 2014, including five deaths. In all but one case, cancer was diagnosed well before the median age observed in the general French population. The most frequent occupational exposures were to polymers, nanomaterials, powders, particles and dust, solvents and the use of devices using X-ray beams. Comparison of potential exposures of the cases with the risk factors did not show a match for all the cancers. However, four cases had potentially been exposed to X-ray beams, which is an established risk factor for the types of cancers in question. This exposure is not, however, established on the basis of the results of measurements carried out during the period of use of the X-ray device by the cases.

Finally, the investigation did not identify any link between the seven cases of cancers and a common occupational exposure in this laboratory. Moreover, the young age of the workers and the limited laboratory work time before diagnosis do not support a link with occupational exposure. Santé Publique

France recommended the establishment of rigorous monitoring of jobs and of exposures for all workers in the laboratory.

Examples of data usage for detection of new/emerging WRDs

Case of severe silicosis associated with reconstituted stones (Santé Publique France, 2016c)

ANSES reports a potential risk among professionals who work with reconstituted stone (also known as 'engineered stone' or 'artificial stone'), composed of natural marble/granite granulates and powder combined with a highly specialised polyester resin. Reconstituted stone contains very high levels of crystalline silica and is used to make kitchen worktops or bathroom surfaces. Foreign publications (from Israel, Spain and elsewhere) report cases of silicosis with short latency (about 10 years of exposure), the severity of which may require lung transplants. No cases have yet been reported in France. Although this material is not manufactured in France, many professionals cut and sand imported stones to adjust worktops, for example. These activities must be carried out in a 'wet procedure', with workers wearing a P3 mask.

Renal cancer at a chemical plant (Pascal et al., 2010)

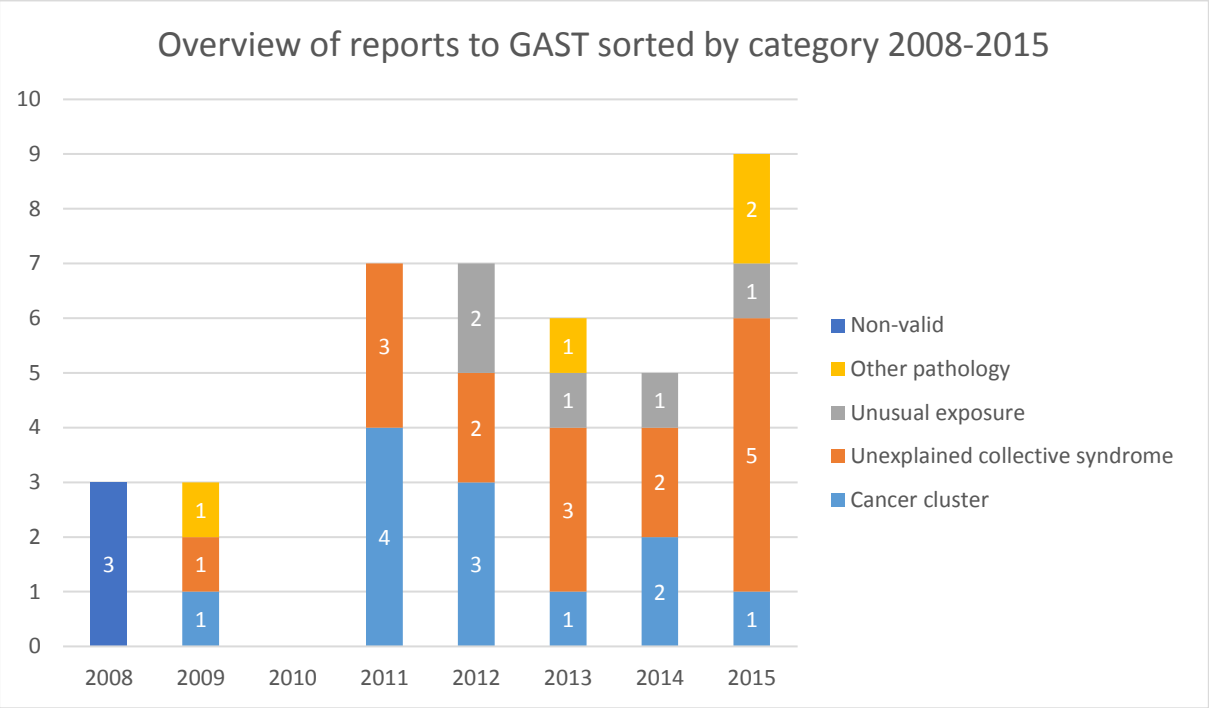
In 2003, a cluster of renal cell carcinoma (RCC) cases was reported among men working at a French chemical plant using a proprietary process to produce vitamin A. The 10 index cases yielded a standardised incidence ratio of 13.1 for 1994-2002. Nine of these 10 cases were diagnosed by a plant-specific abdominal ultrasonography screening programme that targeted exposure to an intermediate chemical, 4-chloro-1,1-dimethoxy-3-methyl-2-butene, commonly named chloracetal C5, suspected by some experts to be the cause. Epidemiological investigations sought to examine the relations between occupational exposures and RCC. A retrospective cohort mortality study and a nested case-control study were conducted. The cohort study included all workers who had been employed at the plant for at least six months between 1960 and 2003. The case-control study included an extensive search within the region for other kidney cancer cases among the cohort members. Industrial hygienists assessed occupational exposure. From 1968 to 2006, no significant excess mortality was observed for all causes of death or for all cancers. Excess mortality for kidney cancer was found only among women. The nested case-control study showed a dose-response relationship for cumulative exposure to chloracetal C5. The odds ratio rose from 2.5 in the low-exposure category to 10.5 in the high-exposure group, although adjustment for screening attenuated this relation.

Other examples of data usage

Before the introduction of GAST, InVS already gathered reports of unusual health events at the workplace. From 2008, GAST began to assess these cases in a growing number of regions.

Between 2008 and 2015, 40 reports of unusual health events were dealt with as part of GAST. About 80 % were notified by OHSs. Of the reports, 87.5 % (35) concerned a disease, and 12.5 % (5) originated from an exposure. Among the health problems reported, the majority concerned non-specific symptoms such as headaches or irritations often associated with unexplained collective syndromes (16), and suspicions of cancer clusters (12). In terms of responsiveness, half of the reports were the subject of a GAST meeting within 10 days of receiving the signal. The average response time, from reception of the signal and the first consultation of GAST members, was 18 days (minimum, 1 day; maximum, 2.5 months). The mean time from receipt of the signal to the closing of the report was seven months (minimum, seven days; maximum, three years). The longest times were for reports of suspicions of cancer clusters.

Figure 5. Reports assessed by GAST, 2008-2015



Source: http://invs.santepubliquefrance.fr/fr../Dossiers-thematiques/Travail-et-sante/Alertes-en-sante-travail/Bulletin-des-reseaux-de-surveillance

3.3.3 NIOSH Health Hazard Evaluation Program (USA)

- **System's aim and objectives**

The NIOSH Health Hazard Evaluation (HHE) Program is a programme for identifying chemical, biological or physical hazards at the workplace. The programme is hosted by the National Institute for Occupational Safety and Health (NIOSH). A priority of the programme is to evaluate and identify new and emerging hazards.

The mission of the HHE Program is to respond to written requests to investigate potential OH hazards at workplaces, as defined by the Occupational Safety and Health Act of 1970 and the Federal Mine and Safety Act of 1977, and in federal agencies, including the military. Its objectives are:

- to prevent occupational illnesses through reduced exposure to workplace hazards;
- to promote OSH research on emerging issues;
- to protect the health and safety of workers during public health emergencies.

HHEs can be particularly useful in the following circumstances:

- when the hazard is new or previously unrecognised;
- when workers have illnesses from an unknown cause;
- when workers are exposed to chemical, biological or physical agents or processes that are not regulated;
- when workers experience adverse health effects from workplace exposures even though exposure standards are not exceeded;
- when OH physicians or epidemiologists are needed to fully evaluate the hazard.

- **Description of the system workflow**

Reporting parties

The law defines who may submit requests for investigations: a request must be from an employer, a union, an employee representing at least two other employees, a single employee if the work area of concern has three or fewer employees, a federal agency, a health and safety committee, federal employees not covered by such a committee, or the Secretary of Labor. When requested by employees, an application submitted by at least three employees is sufficient for an HHE unless there are three or fewer employees in the workplace, in which case only one employee requestor is needed.

Work-relatedness evaluation

No specific work-relatedness evaluation is performed. In the HHE, multidisciplinary teams carry out workplace evaluations upon receiving a request to collect data and evaluate cases. These teams consist of experts assigned by the programme staff members depending on the nature of the reported problem. A NIOSH HHE multidisciplinary team may comprise industrial hygienists, physicians, epidemiologists, veterinarians, health communicators, statisticians, psychologists, support staff, engineers, toxicologists, chemists and other NIOSH specialists.

The majority of HHEs are conducted by the Hazard Evaluations and Technical Assistance Branch (HETAB) of the Division of Surveillance, Hazard Evaluations and Field Studies located in Cincinnati, Ohio, and the remainder are conducted by the Field Studies Branch of the Respiratory Health Division located in Morgantown, West Virginia. NIOSH also has three regional offices managed by HETAB, which are located in Atlanta, Georgia; Boston, Massachusetts; and Denver, Colorado. They have limited numbers of staff also responsible for conducting HHEs.

Reporting mechanism

HHE is a voluntary (request-driven) system; after a request is received from employers, employees or employee representatives, or other public sector agencies, multidisciplinary teams carry out active workplace evaluations. The NIOSH HHE Program allocates resources to incoming requests for HHEs through a formal triage process.

Incoming HHE requests are then reviewed by a multidisciplinary panel of senior OH professionals using a set of selection criteria, and are assigned to one of four possible categories:

- Category I requests are those outside the scope of the HHE Program (for example concerning safety rather than health, or a former rather than current employee) and are referred to another agency. For Category I HHE requests, a letter of referral is sent to the requesting party.
- Category II requests are either invalid – and, by regulation, cannot receive a site visit – or about a problem that can probably be resolved without a site visit or that a site visit is unlikely to resolve. For Category II HHE requests, responses include consultation by telephone, critical review of previous evaluations and other written material, and sending a letter to the requesting party and facility manager with pertinent information. Examples include indoor environmental quality/mould problems, non-industrial cancer clusters or well-known hazards for which good guidance is available.
- Category III requests are those that would benefit from a site visit. In these cases, at least one site visit is performed and a report is written on completion.
- Category IV requests are those that involve complex medical or epidemiological investigations, development and the use of new sampling and analytical methods, or feasibility studies. In these cases, at least one site visit is performed and a report is written on completion.

The type of NIOSH personnel required for each HHE request is also decided during the triage process. Most of the HHEs requiring a site visit have at least medical and industrial hygiene components. The teams comprise industrial hygienists, physicians, and other OH specialists (including epidemiologists, psychologists, engineers, and statisticians).

Examples of problems that may require a site visit (Category III or IV) are:

- serious health issue or illness of unknown cause;

- new, unique and unfamiliar hazards;
- known hazards in new places;
- exposure to unregulated agents or hazards;
- medical or epidemiological investigations required;
- complex problem or research opportunity.

Response with a site visit may include:

- observation of work practices and procedures;
- discussions with workers, supervisors, managers and union representatives;
- review of exposure records, illness and injury logs, and health records;
- collection of environmental and biological samples;
- confidential medical interviews, examinations and questionnaires;
- evaluation of controls.

HHE site visits are performed in accordance with the procedures described in 42 CFR 85, Requests for Health Hazard Evaluations (GPO, 2012). Typically, to begin the process, the NIOSH project officer contacts the requesting party to obtain pertinent background information. The company and employee representatives (if other than the requesting party) are then contacted to explain the HHE request and process, obtain additional background information and schedule a site visit. The appropriate federal – Occupational Safety and Health Administration (OSHA), Mine Safety and Health Administration (MSHA) or other – state and local government agencies are then notified.

At the start of an HHE site visit, NIOSH investigators hold an opening conference with the facility's management and employee representatives to describe the HHE request and explain the nature, purpose and scope of the evaluation and to request records for review. The facility management is then asked to identify any trade secret information, which NIOSH is required to keep confidential. After the opening conference, NIOSH investigators perform an observational walk-through of the facility's work areas of concern with management and employee representatives to see the work processes, exposure controls and work practices. NIOSH investigators may then measure workplace exposures by direct-reading methods or by obtaining environmental samples, conduct confidential interviews with workers, administer health symptom questionnaires, collect biological samples, perform medical tests or physical examinations, and review exposure and health records. After an HHE site visit, NIOSH investigators hold a closing conference with the facility's management and employee representatives to review their activities, present preliminary observations and recommendations, and discuss any future plans. When appropriate, a protocol for future assessments at the facility is prepared for review by the NIOSH Institutional Review Board.

Communication

Written reports containing recommendations of evaluations are shared with employer and employee representatives at the worksite that is the subject of the investigation. Employers are required to display the final NIOSH report in the workplace.

Data storage

As HHE requests are received, they are logged into an electronic database that is used to track the progress of each HHE. The HHE Program has an administrative database that contains no health or exposure information. However, a final report database is accessible to the public, and can be searched by health or exposure topic or by industry.

▪ Dissemination of findings

A final report, containing a determination of hazard and recommendations to address hazardous exposures or harmful conditions found during the HHE, is distributed to the requesting party/ies, employee representative(s), employer, health department, Department of Labor (OSHA or MSHA) and, as appropriate, other federal, state and local government agencies. HHE final reports comprise a comprehensive technical report with findings and recommendations and a plain language 'highlights' page. Reports must be displayed for 30 days in the workplace that was the subject of the evaluation.

The final reports are also available on the NIOSH website's HHE Program topic page (http://www.cdc.gov/niosh/hhe/) and are available through the NIOSH eNews subscription service.

Follow-up

Since 2000, the HHE Program has been conducting 'followback' activities with workplaces that the programme has evaluated. Through these activities, NIOSH learns how to better serve workplaces. The workplaces served may learn more about implementing HHE recommendations.

A followback may include one or more of the following activities:

- surveys sent to each party after the first site visit, when the final report is released and one year after the final report was released;
- a conference call with the employer, employees and union representatives after the final report has been released, to address any questions about the information provided in the report and any concerns about implementing the recommendations;
- a return visit to the workplace to see changes that have been made on the basis of the recommendations provided; exposure and health testing may be repeated to document the effectiveness of the changes made.

HHE followback activities show NIOSH investigators:

- how useful the final report was to employers and employees at the workplace;
- how well the recommendations addressed the workplace concerns that prompted the request;
- whether a new hazard or new solution to a hazard was found;
- whether additional assistance is needed;
- new information that may be useful to other workplaces with similar concerns.

The followback results are entered into a database, to be analysed periodically so that summary reports can be prepared. This information is used to make changes to the NIOSH HHE Program to enhance its effectiveness and impact.

▪ Financial aspects

No information on financial aspects is available.

▪ Usage of data

Examples of data usage for informing policy and prevention

Evaluation of an unregulated exposure – eye and respiratory irritation in a turkey-processing plant

NIOSH received a request from the Occupational Safety and Health Bureau of a state's Division of Labor to investigate reported health effects at a turkey-processing plant. Employees in the evisceration department of the plant were experiencing symptoms such as eye and respiratory irritation.

During the initial survey, the NIOSH investigators performed a detailed walk-through of the plant, evaluated air flow patterns in the evisceration department and administered questionnaires to workers in the evisceration and dark meat departments. The questionnaires covered medical, job and personal history, and work-related symptoms. Direct-reading area air samples were also collected in those departments for chlorine, ammonia and carbon dioxide levels, temperature and relative humidity. No chlorine or ammonia was detected.

During a subsequent survey, NIOSH investigators collected personal breathing zone (PBZ) and area air samples for chloramines and endotoxins in the evisceration and dark meat departments of the plant over a five-day period. Area air samples were collected for direct reading of chlorine and carbon dioxide levels, temperature and relative humidity throughout the week. Every individual who wore air-sampling equipment was also asked to perform spirometry immediately prior to, and directly after, his or her work shift. They were also questioned about mucous membrane and respiratory symptoms experienced during that shift.

The concentrations of chloramine (trichloramine) and soluble chlorine compounds were significantly higher in the evisceration department than in the dark meat department. In addition, upper respiratory irritation symptoms, such as stuffy or itchy nose, frequent sneezing, coughing, and burning or stinging eyes, were found to be significantly more prevalent among the evisceration workers than the dark meat workers. The levels of soluble chlorine compounds measured by PBZ samples were significantly higher among the employees who reported these symptoms than among the employees who did not.

In addition, exposure to airborne trichloramine concentrations was significantly higher among employees who reported burning or stinging eyes. Mean PBZ concentrations of trichloramine and soluble chlorine compounds were also higher among workers with significant cross-shift declines in lung function. Endotoxin levels were considerably higher in the evisceration department than in the dark meat department, although they were not significantly related to the reported employee symptoms.

The results of this evaluation suggested that a health hazard may exist from exposure to soluble chlorine compounds and trichloramine, which are unregulated chemical compounds. Recommendations were made to modify the plant's ventilation system in order to maximise its ability to dilute and exhaust airborne contaminants.

Evaluation of health effects when exposure standards are not exceeded

NIOSH received a request from the state's Department of Human Services to investigate reported health effects at a plant that manufactured microporous polyethylene battery separator material. Employees exposed to trichloroethylene (TCE) were reporting dementia and neurological dysfunction.

During the initial survey, the NIOSH investigators performed a detailed walk-through of the plant, collected direct-reading area air samples of TCE and administered questionnaires to workers in the production area of the plant. The questionnaires covered medical, job and personal history, and work-related symptoms. Questionnaires were also administered to workers with no TCE exposure, for comparison.

Airborne concentrations of TCE ranged from 20 to 40 ppm, generally above the NIOSH recommended exposure limit (REL) of 25 ppm but below the OSHA permissible exposure limit (PEL) of 100 ppm. Employees also reported a higher prevalence of symptoms that prior studies have related to solvent exposure.

During a subsequent survey, full-shift and short-term PBZ and area air TCE samples were collected in the plant over a five-day period. Every worker wearing air-sampling equipment was also administered a detailed health symptom questionnaire, underwent a series of five objective neuropsychological tests and provided end-of-shift and end-of-week urine samples to measure trichloroacetic acid, a metabolite of TCE. Again, workers with no TCE exposure were given the same questionnaire and neuropsychological tests, and provided urine samples for comparison.

Mean airborne PBZ concentrations of TCE ranged from 3.1 to 37 ppm, with most of the sampled jobs above the NIOSH REL but below the OSHA PEL. Short-term, task-based airborne TCE concentrations ranged from 30 to 445 ppm. Results from three of the five neuropsychological tests indicated sub-clinical effects among TCE-exposed workers. Urine sample results indicated that the exposures of 27 % of workers were above the American Conference of Governmental Industrial Hygienists Biological Exposure Index for TCE.

NIOSH recommended that workers wear appropriate respirators until recommended engineering controls could be implemented to reduce TCE exposures. This investigation is still ongoing but the results to date suggest that the OSHA PEL for airborne TCE may not protect workers' health.

Examples of data usage for detection of new/emerging WRDs

Evaluation of a new problem: bronchiolitis obliterans in a microwave popcorn plant

NIOSH received a request from an official in a state's Department of Health and Senior Services to investigate severe obstructive lung disease (bronchiolitis obliterans) in former workers at a microwave popcorn plant. Affected workers had worked in the room where butter flavouring was mixed into heated soybean oil (mixing room) and in the adjacent microwave popcorn packaging area.

An initial NIOSH medical and environmental survey at the plant showed that employees' rate of obstruction on spirometry was 3.3 times the national rate, and that the prevalence of obstruction in never-smokers was 10.8 times the national rate. The majority of workers with obstruction had fixed obstruction (unresponsive to bronchodilators), and most chest X-rays and diffusing capacity tests were normal. The findings are consistent with constrictive bronchiolitis obliterans.

In addition, five out of six quality control workers, who repeatedly popped bags of the product in microwave ovens (approximately 100 bags per worker per work shift) in a poorly ventilated room, were found to have obstruction on spirometry. A strong exposure-response relationship was demonstrated between quartiles of estimated cumulative exposure to diacetyl (a volatile butter-flavouring chemical) and the incidence of airway obstruction on spirometry.

Subsequently, NIOSH investigators conducted a detailed engineering control assessment and provided exposure control recommendations. In response, the microwave popcorn plant management began to implement NIOSH's exposure control recommendations. NIOSH investigators continued to perform periodic medical and environmental surveys to determine if the implemented controls were effective in reducing exposures and protecting the health of workers.

As a result of the implementation of exposure controls, average airborne diacetyl concentrations decreased from 38 to 0.46 ppm in the mixing room, from 0.54 to 0.002 ppm in the quality control laboratory and from 1.69 to 0.002 ppm for machine operators in the packaging area. Among workers hired prior to the first NIOSH survey, there was a statistically significant decline in the prevalence of eye, nose and throat irritation but no significant changes in the prevalence of other symptoms or spirometry abnormalities or in mean percentage of predicted forced expiratory volume in one second (FEV1).

Workers hired after the first NIOSH survey had a lower prevalence of symptoms and spirometry abnormalities, and a higher mean percentage of predicted FEV1 than workers hired prior to the first NIOSH survey. There were no statistically significant changes in these outcomes over time for those workers hired after the first NIOSH survey.

The NIOSH investigation at this microwave popcorn plant determined that inhalation exposure to butter-flavouring chemicals is a new risk factor for occupational obstructive lung disease. It resulted in a NIOSH alert to warn the flavouring industry about lung disease among workers who use or make flavourings (Kanwal et al., 2006).

Evaluation of an illness of unknown cause: intermittent blurred vision in a printing company

NIOSH received a request for an HHE from the management of one of the largest flexographic printing or product labelling operations in the USA. Many employees in the plant had been experiencing intermittent blurred vision, described as looking through 'a fog' or 'a mist'. The plant had already been evaluated by industrial hygienists from the state's Bureau of Workers Compensation and a private contractor, and some of the employees had been examined by an ophthalmologist. No one could determine the cause of the blurred vision.

The NIOSH investigators performed a detailed walk-through of the facility and developed the hypothesis that the most likely culprit was one or both of two tertiary amine compounds used in the plant. Despite case reports of blurry, halo and/or blue-grey vision among workers exposed to a variety of amines, previous studies have failed to document the mechanism of the visual disturbances or to associate them with occupational exposures, probably because of limitations in study design and/or sampling methods.

The amine compounds used in the plant had never been reported as causing visual disturbances. During a subsequent survey at the plant, full-shift PBZ air samples were collected for the two tertiary amines, dimethyl-isopropanol-amine (DMIPA) and dimethyl-amino-ethanol. A questionnaire survey, enquiring about work practices and symptoms, and eye examinations was performed daily for two weeks at the beginning and end of both work shifts.

The exams were conducted by a contracted ophthalmologist and tested visual acuity, contrast sensitivity at 2.5 % and 1.2 % contrast, ultrasonic pachymetry to determine corneal thickness and a slit lamp examination to determine the presence of corneal opacity. Symptoms of blurry, halo and blue-grey vision, corneal opacity, and decrements in visual acuity and in contrast sensitivity at 2.5 % contrast were found to be significantly associated with time-weighted average exposure to the tertiary amines.

The NIOSH investigators informed the plant managers, who diluted the pH adjuster (which contained DMIPA) with water, which immediately resolved the visual complaints. NIOSH investigators confirmed this by performing follow-up interviews and additional air sampling, documenting the absence of visual disturbances and a significant decline in total tertiary amine levels.

The mechanism of corneal opacity action was found to be the direct deposition of DMIPA into the corneal epithelium without significant cellular dysfunction or toxicity. NIOSH then recommended that the material safety datasheets for the amine-containing products used at the plant be modified, and it alerted ophthalmologists to the adverse ocular effects of exposure to these tertiary amine compounds. As a direct result of this study, these tertiary amine compounds are now included in the NIOSH/Bureau of Labor Statistics Disease Agent Survey, which is designed to assess nationwide exposure to important disease-causing chemicals (Page et al., 2002).

3.3.4 SENSOR-Pesticides (USA)

- **System's aim and objectives**

The SENSOR system began in 1987 (Baker, 1989). The original idea of this system was to set up sentinel providers that would be linked to NIOSH and provide information on any identified work-related health problems. The SENSOR-Pesticide Program is the only remaining system of the initial SENSOR that has retained its original name, whereas schemes for other WRDs developed into independent systems with different names. The SENSOR-Pesticides Program is specifically aimed for identification of emerging pesticide-related health problems. The objective of this system is closely linked to activities of the federal EPA, which creates the laws that regulate pesticide use and delegates the enforcement authority in each state. SENSOR-Pesticides provides post-marketing surveillance, after pesticides are tested for possible risks and officially put on the market. This system is in charge of detecting any adverse health effects that could be linked to exposure to pesticides launched on the market. In this sense, SENSOR has a similar design to the corresponding system in the drug industry for post-marketing surveillance of adverse events in the use of approved drugs.

- **Description of system workflow**

Reporting parties

Originating in the 1980s, SENSOR is the first OSH surveillance system to be designed according to the sentinel approach (Baker, 1989). The initial goal of this system was to provide information on any identified work-related health problems, and the main reporting parties were physicians across the USA. However, the structure of SENSOR changed over time, and reporting physicians were replaced by the other three main sources of data information: the State Department of Agriculture, poison control centres and the workers' compensation system.

Cases of pesticide poisoning, reported mainly by telephone, are daily transferred from the State Department of Agriculture and poison control centres to the state health departments. Workers' compensation data are transferred on a weekly basis. Experts from the state health departments also apply a data mining method by using the established search algorithms in order to identify compensation cases related to pesticide poisoning. The state health departments play a significant role in the data collection process, as they are the public health authorities and are supported by the state laws that require all healthcare providers to report pesticide poisoning to the state health department. This organisational model proved currently covers 13 out of 50 states across the USA.

Work-relatedness evaluation

Experts in the state health departments perform the first assessment of cases to select those that fit the definition determined by NIOSH in its "Case Definition for Acute Pesticide-Related Illness and Injury Cases Reportable to the National Public Health Surveillance System" (NIOSH, 2012).

For the case definition, a case is characterised by an acute onset of symptoms that are dependent on the formulation of the pesticide product and involve one or more of the following:

- systemic signs or symptoms (including respiratory, gastrointestinal, allergic and neurological signs/symptoms);
- skin lesions;
- eye lesions.

NIOSH has also determined criteria for classifying a case as "occupational if exposure occurs while at work (this includes working for compensation; working in a family business, including a family farm; working for pay at home; and working as a volunteer emergency medical technician, firefighter or law enforcement officer). All other cases will be classified as non-occupational. All cases involving suicide or attempted suicide should be classified as non-occupational (NIOSH, 2012).

In addition, a case can be reported to the SENSOR surveillance system when it has (NIOSH, 2012):

- documentation of new adverse health effects that are temporally related to a documented pesticide exposure; AND
- consistent evidence of a causal relationship between the pesticide and the health effects based on the known toxicology of the pesticide from commonly available toxicology texts, government publications, information supplied by the manufacturer, or two or more case series or positive epidemiologic investigations; OR
- insufficient toxicological information available to determine whether or not a causal relationship exists between the pesticide exposure and the health effects.

If available, laboratory data can be used to confirm exposure to a pesticide.

Reporting mechanism

After the initial screening of the reported case, the expert from the state health department assigns an investigator to follow up the case. As the information provided by the initial report of a case is usually scarce, experts from the state health department who asses the case need to obtain additional data in order to determine whether or not the abovementioned criteria are fulfilled. This process differs among states. In some states, further information is gathered through medical records exclusively, whereas in others data are collected through telephone interviews with the worker or even through worksite inspections. The latter usually takes place in larger agricultural pesticide drift events, when the investigators often go on site, sometimes accompanied by an investigator from the state departments of agriculture and labour.

Cases are then scored on the basis of the classification criteria provided by NIOSH and described in its documentation. For each of the aspects 'exposure', 'health effects' and 'causal relation' there are specific criteria defined to classify them from 1 (strong evidence) to 4 (evidence lacking). Furthermore, the classification matrix is provided with the case classification categories and the criteria scores needed to place the case in a specific category. The categories are definite cases, probable cases, possible cases, suspicious cases, unlikely cases, cases with insufficient information and not a case (Table 11).

Table 11. Case classification matrix

Classification criteria	Classification categories[a]										
	Definite case	Probable case		Possible case	Suspicious case	Unlikely case	Insufficient information		Not a case		
									Asymptomatic[b]	Not related[c]	
A. Exposure	1	1	2	2	1 or 2	1 or 2	4	-		3	
B. Health effects	1	2	1	2	1 or 2	1 or 2	-	4	3		
C. Causal relation	1	1	1	1	4	2	-	-			3

a Only reports meeting case classifications of definite, probable, possible and suspicious are reportable to the national public health surveillance system. Additional classification categories are provided for states that choose to track the reports that do not fit the national reporting criteria.

b The matrix does not indicate whether or not asymptomatic individuals were exposed to pesticides, although some states may choose to track the level of evidence of exposure for asymptomatic individuals.

c Unrelated = illness determined to be caused by a condition other than pesticide exposure, as indicated by a 3 in the evidence of exposure or causal relationship.

Source: NIOSH, 2012

Definite, probable, possible and suspicious cases are reportable to the national surveillance system. Additional classification categories are provided for states that choose to track reports that do not fit the criteria for national reporting.

Furthermore, a severity index is assigned to all the cases classified as definite, probable, possible or suspicious. This severity index is based upon existing systems for ranking the severity of poisonings, including pesticide illness. It takes into account the following: signs and symptoms, whether or not medical care was sought, whether or not the individual was hospitalised, and whether or not lost time from work or usual activities occurred. In this way, this severity index is used in conjunction with the case definition determined by NIOSH. Severity categories are death, high-severity illness or injury, moderate-severity illness or injury, and low-severity illness or injury.

Communication

Workers receive no active feedback within the SENSOR reporting system. However, if a worker wants to know more about his or her case, the state will provide the information, and this kind of feedback needs to be initiated by the worker.

On the other hand, feedback to the reporting centres is a common step in the assessment procedure. This is critical for maintaining reporting to the surveillance programme and ensuring that this very educational aspect is used to deliver prevention information.

Data storage

The collected data on each poisoning case are organised using variables. For all variables that are collected, states are encouraged to use standardised formats. The standardised variables are the following.

- Administrative and demographic variables: information on the source(s) of the report, relevant dates, event identifiers, county and state of exposure and residence, sex, age, ethnicity and race.
- Occupation and industry data: occupation is coded using either US Bureau of Census codes (National Centre for Health Statistics 2003) or the 2000 Standard Occupational Classification codes. Codes for industry can be based on either Bureau of Census codes (NCHS 2003) or North American Industry Classification System codes.
- Exposure descriptions: type of exposure (drift, direct spray, indoor air, contact and so on), route(s) of exposure, whether or not the exposure was intentional, the person's activity at the time of exposure and protective equipment worn by the exposed person. This item also captures information on the equipment used to apply the pesticide, what the intended target of the application was, where the pesticide was being applied and where the person was located when exposed (farm, nursery, home, school, manufacturing facility and so on).
- Chemical information: information on the pesticide product(s) associated with the exposed person's illness or injury.
- Health effects description: information on biological monitoring, medical diagnosis, pre-existing conditions, signs and symptoms, type of care received, and whether or not the person lost time from work or regular activities.
- Investigation findings.
- Case classification.

Stored data are submitted to NIOSH annually and NIOSH uses the data to assemble an aggregated database.

- **Dissemination of findings**

Results of the site inspections are disseminated through written reports of findings provided to the affected person(s), and the employer or third party responsible for the pesticide application. In the case of worksite inspections, a summary report may be provided to all interviewed workers. This report should clearly communicate any recommendations arising from the case assessment. Follow-up to determine if these recommendations are adopted should be conducted after an appropriate time interval. Follow-up may be conducted by mail, telephone or a site visit, especially if the recommendations include engineering controls.

- **Financial aspects**

The estimated costs of maintaining the SENSOR-Pesticides system are approximately USD 1 million to USD 2 million per year. The system's financial resources differ among the participating states and are mostly provided by either NIOSH or EPA, although some states are currently self-supported. Of the 13 states participating in the SENSOR-Pesticides programme, the following 5 receive federal funding and NIOSH technical support to bolster pesticide-related illness and injury surveillance: California, Illinois, Michigan, Texas and Washington. The other eight receive technical support from NIOSH, but are federally unfunded SENSOR-Pesticides partners: Florida, Iowa, Louisiana, Nebraska, New Mexico, New York, North Carolina and Oregon.

- **Usage of data**

Examples of data usage for informing policy and prevention

Usage of data collected by the SENSOR-Pesticides programme for prevention and policy is closely related to the activities of EPA. As mentioned before, one of the tasks of EPA is the legal regulation of pesticide use. More specifically, the EPA Office of Pesticide Programs (OPP) is dedicated to reviewing pesticide products and potential risks to human health, the environment and the users, be they home owner users or professional appliers. The OPP registers pesticides before they are released onto the market. The pesticide industry and the registrant who develops the chemical and the product have to submit to a variety of different OPP studies to provide evidence that the product is safe. OPP experts assess and evaluate these findings. The role of SENSOR-Pesticides is to provide EPA with additional data on adverse health effects caused by pesticides, which will then be integrated into the ongoing re-evaluation process of new chemicals. Some of the incidence data are also gathered through the EPA Incidence Data System, but this system focuses on home pesticide users and owners, and thus excludes a large group of users, for instance commercial operators, pest control operators and farm appliers. Therefore, data provided by SENSOR are of great importance in the overall pesticide registration and evaluation procedure.

SENSOR-Pesticides enables the identification of the root causes for pesticide-related illnesses among **farm workers**, which has led to the most dramatic revision to the worker protection standards in the last 20 years. A great deal of work was conducted to make these standards more modern, more protective and closer to OSHA labour standards. In addition, these changes were intended to provide much more hazard and safety information to farm workers and to make agriculture employers more accountable for complying.

Another example is the changes in the law related to pesticide use in schools after identification of **pesticide poisoning associated with pesticide use at schools**. Most of the data regarding this issue were derived from SENSOR-Pesticides. After an article on this topic was published in 2005, several states adopted laws requiring schools to use integrated pest management practices for pest control (Alarcon et al., 2017). The article also served as evidence for the advocates of integrated pest management in schools to highlight the issue of using pesticides in schools, and to insist on the application of alternative (non-chemical) measures whenever possible.

SENSOR data also highlighted **adolescent workers** as a vulnerable group with regard to pesticide exposure. After publishing the results (Calvert et al., 2003), EPA changed the worker protection standard

and the certification and training standard. A minimum age of 18 years has been determined for workers applying pesticides in agricultural areas.

Another vulnerable group of workers identified through SENSOR is **pregnant farm workers**. Three farmworkers who gave birth to infants with severe birth defects were identified, and a case report on this issue was published in 2007 (Calvert et al., 2007). The cases were grouped in time and space: three infants were born within eight weeks of one another to mothers who worked for the same tomato grower in Florida. It was documented that they had all been exposed to pesticides by going into fields prematurely. In addition, the women had not used the appropriate personal protective equipment. This article was cited in the revision of the worker protection standard, and some specific protective measures aimed at pregnant farm workers as a particularly vulnerable group were raised.

Examples of data usage for detection of new/emerging WRDs

SENSOR data from 2001 to 2005 were analysed to investigate possible **health risks related to exposure to pyrethrins and pyrethroids**. Pyrethrins and their synthetic derivatives, pyrethroids, have become the predominant class of insecticide for public health and residential uses thanks to their low environmental persistence and the slow development of resistance to them in pests. They were also introduced as a less hazardous substitute for organophosphate insecticides in the 1990's. SENSOR data revealed several pyrethrin or pyrethroid pesticide poisonings, of which approximately one-quarter were work-related cases. A list of clinical signs and symptoms reported by people with pyrethrin or pyrethroid poisoning was compiled, thus revealing respiratory symptoms as the most common category, followed by neurological and gastrointestinal symptoms. Whereas some of the listed symptoms had already been linked with pyrethrin and pyrethroid exposure, several additional health effects were revealed that had not been previously recognised in this context (mainly respiratory symptoms). Moreover, data analysis showed that pre-existing conditions such as allergies and asthma were significantly associated with chemical sensitivity and illness severity.

These data were published in an article in 2009 and were a basis for composing a list of recommendations for EPA, emergency response workers, state agencies or health departments, and healthcare providers (Walters, 2009).

SENSOR data from 2001 to 2007 were used to evaluate **the health effects of Fipronil, a relatively new pesticide**, after its introduction into the market. Fipronil is a broad-spectrum phenylpyrazole insecticide, widely used to control residential pests, and is also commonly used in the flea and tick treatment of pets. A paper by Lee et al. (2010) described the magnitude and characteristics of acute illnesses associated with Fipronil exposure. A total of 103 cases were identified in 11 states. Annual case counts increased from 5 in 2001 to 30 in 2007. Of the patients, 55 % were female, the median age was 37 years and 11 % were under 15 years old. The majority (76 %) had been exposed in a private residence, 37 % of the cases involved the use of pet care products and 26 % had work-related exposure. Most cases (89 %) had mild, temporary health effects. Neurological symptoms (50 %) such as headaches, dizziness and paraesthesia were the most common, followed by ocular (44 %), gastrointestinal (28 %), respiratory (27 %) and dermal (21 %) symptoms/signs. Exposures usually occurred from inadvertent spraying/splashing/spills of products or inadequate ventilation of the treated area before re-entry. The authors concluded that exposure to Fipronil may pose a risk of mild, temporary health effects in various body systems, and that precautionary actions should be reinforced to prevent Fipronil exposure among product users (Lee et al., 2010).

- **Stakeholders' views**

Drivers and obstacles

Drivers	Obstacles
The motivation of healthcare providers to report is essential.	The motivation of healthcare providers to report is also an obstacle as much as a driver. One of the stakeholders hinted that automation of the reporting procedure may be a possible way to deal with this issue.

Drivers	Obstacles
Even though reporting is mandatory, stakeholders emphasised an additional need to encourage reporting. With regard to this, the ability to contact the poison control centres makes the reporting procedure easier, especially if the reporting party is uncertain about the case. Stakeholder 2 (reporter): 'We've tried to get the word out that all you have to do is call the poison centre … But over the years it has helped if they know that, if they're not sure if they should report it or not, they just call the poison centre and that helps.'	Stakeholder 2 (reporter): 'What's true in the United States I can say is that unless there's a real reason why a physician would want to report it they're not going to report it: nobody's going to fine them or penalise them for not reporting. So, we need the automated systems. So, the first visits when folks first come to a clinic or an emergency room, there should be some way to just check a box if this is a reportable condition. And then it could be automatically transferred.'
Other states need motivation to participate. This is not necessarily linked to financial support; it is more closely related to confirmation of the value of the system that the participating states have experienced. Therefore, it is essential to demonstrate the value of the system by analysing and publishing gathered data as well as providing recognition to all the participating states and stakeholders of the overall work of SENSOR. Stakeholder 1 (owner): 'Well, I think it's kind of interesting that out of the 13 states that currently participate, only 5 of them are currently receiving federal support. And so the other eight states, even when they previously received federal support but no longer do, they typically don't drop out of the system. They still collaborate, they see the value of the system, they see that we're productive, that we use this data, we write these reports and that our programme has impacts. We share our findings with the EPA. And the EPA adopts regulations to address the issues that we identify.'	Even though finances are not always the determining factor for motivating individuals and states, they often limit human resources and thus indirectly affect the quality of gathered data. As mentioned before, the unequal distribution of money between the participating states often leads to varying quality of reported data. In addition, the lack of human resources makes data cleaning and analysis more difficult and creates a time lag between the period of data collection and dissemination. Stakeholder 3 (researcher): 'Priorities have shifted. We literally have no capacity, funding or resources to support the states anymore. So that's a huge problem that we have to think about addressing, because if there are unfunded states there are absolutely less cases, less coding and sometimes they fall out.'
In terms of drivers for prevention, interviewees pointed out the collaboration with EPA, which is crucial for using SENSOR data for policy and prevention. However, this collaboration is often driven by politics, which determines the level of recognition and financial support that will be given to environmental protection and safety. Stakeholder 2 (reporter): 'One of the key users is the environmental protection agency. And they have used our data and you can see it in the revision of the workers' protection standards. They're such a key organisation in serving our data.'	

Data quality

Some interviewees expressed their concerns about the quality of the coded data in the reporting form. Experts from NIOSH often spend a lot of time cleaning the data before they can be used for dissemination and publication in scientific papers. However, NIOSH is applying measures to address this issue. Twice a year, a quality control exercise is performed in the states, which consists of sending out a series of questions or scenarios to be coded. Afterwards, all the answers are collected and compared with the coding done by the NIOSH experts. The findings are presented, and each question is thoroughly discussed, pointing out the states that gave the right and wrong answers. This takes place in the form of webinar or a workshop that brings everybody together in person. Overall, data collected by SENSOR are considered detailed and valuable, as long as the cases are coded adequately.

Stakeholder 3 (researcher): 'I think it's the very best quality there is for pesticide incidence because of the depth of detail that is provided when the state person has the time and ability to really thoroughly code the case.'

As described by one of the stakeholders, poor quality of aggregated data is often linked to financial limitations:

Stakeholder 3 (researcher): 'It's limited in some states that don't have any federal funding and have way less time to devote to coding the cases. We pretty much only do the very basics, so there are many blanks.'

It is worth mentioning that the data collected differ between the states that take part in the SENSOR-Pesticides programme. For instance, some states that have poorer funding do not follow up all the cases of pesticide poisoning but rather focus on occupational pesticide poisoning, which is in line with the mission of NIOSH to protect workers above all else. However, even some states that focus only on workers are not able to follow up all workers' cases. Consequently, some information is comparable in all the states (mainly the information on conventional pesticides), whereas other information is not comparable (for instance surveillance for anti-microbials, which is poor in many states).

Moreover, data derived from the workers' compensation system are unequally distributed across different states. For instance, in Washington, California and Illinois the link with the workers' compensation system is good, thus providing a significant source of information. However, the other 10 states have very little access to workers' compensation data.

Another point regarding data quality raised during the interviews is the issue of time lag due to data cleaning. By the time the data are refined and available to the users in EPA, there is already a lag of about two years. However, any kind of alert event has priority in analyses and is called 'a high priority exposure event'. In such a case, information from the states is instantly sent to NIOSH and EPA with all the details.

- **Transferability to other countries**

When discussing the transferability of SENSOR-Pesticides to other countries, the interviewees mentioned the well-defined case definition, standardised variables and severity index as items that are transferable and could be used to build a similar surveillance system, regardless of potential differences in data collection or the public health context. Moreover, the Centers for Disease Control and Prevention (CDC) and NIOSH have jointly published a standardised protocol called *Pesticide-Related Illness and Injury Surveillance: A How-To Guide for State-Based Programs* (CDC & NIOSH, 2005), which could be a helpful tool for setting up a pesticide surveillance programme.

Another prerequisite for implementing a system such as SENSOR is funding. Financial support is crucial to provide the necessary training for the people involved in the system, as well as to enable recruitment of competent and motivated professionals. These professionals also need to play the role of mediators, and do a lot of outreach and networking, which is necessary to keep all the stakeholders working together. Finally, federal backup is a significant supporting factor for establishing and maintaining a pesticide surveillance system.

3.4 Public health surveillance covering workers and non-workers

Five public health surveillance systems were described in the Task 1 literature review (EU-OSHA, 2017). A list of these systems and their main characteristics is presented in Table 12. This group of systems 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. Therefore, these systems are mainly maintained by a public health authority, and have a special module for work-related health problems or simply allow reporting of health complaints potentially caused by work. The majority of systems identified in this group are implemented in EU countries (the United Kingdom, Ireland and France) but one system operates in the USA (California). Even though these systems are not designed specifically to monitor new/emerging WRDs, they can detect signals of new WRDs or provide significant information on emerging trends in OH.

Some public health systems have a wide scope and allow the reporting of any type of work-related health complaints. Examples of these kind of systems are modules of **nationwide surveys**: the self-reported work-related illness (SWI) survey (module of the LFS) in the United Kingdom and the Quarterly National Household Survey (QNHS) in Ireland. The two nationwide surveys have similar designs and their 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. Because of the many specificities in their design and characteristics, these surveys will be described in more depth in the next section.

On the other hand, some systems from this group are **aimed at specific WRDs**. Among these, systems were identified for monitoring musculoskeletal disorders – the French National Mesothelioma Surveillance Program (PNSM) – pleural mesothelioma (Programme for Surveillance of Musculoskeletal Disorders in France) and diseases related to pesticide exposure – Pesticide Illness Surveillance Program (PISP) in the USA. The data flows in these systems are similar to those in non-compensation-related systems for data collection and statistics. Data collection is mainly based on voluntary, spontaneous reporting by medical specialists: OH physicians, pneumologists and oncologists for mesothelioma, or surgeons and neurophysiologists in the case of musculoskeletal disorders.

The data collected generally include information on the worker's gender, age, date and place of birth, occupational title and sector of professional activity, exposures and diagnosis. When assessing **exposure**, most of these systems rely on the information described by the reporter. As discussed before, this can be seen as a drawback in detecting new/emerging work-related risks and diseases because there is a limited possibility to investigate exposure-WRD links further.

The national surveys (UK SWI and Irish QNHS) do not provide further evaluation of work-relatedness. However, the lack of work-relatedness evaluation by experts in nationwide surveys cannot be seen as a pitfall because these systems are actually designed to provide **subjective data**, reflecting workers' self-assessment and experience. When combined and compared with other sources of information, coming from systems with more objective assessment and more strict criteria for reporting, these surveys can be a valuable source of data regarding work-related ill health. Moreover, they 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.

Unlike in the national surveys, in the disease-specific public health surveillance systems, the **evaluation of work-relatedness** is carried out by authorised experts. In addition, they provide a detailed investigation of work-relatedness and follow-up for every reported case. However, these systems have a narrower scope and focus on monitoring one specific type of disease, which potentially allows stricter data quality control and engagement in work-relatedness evaluation without too extensive labour demands. So, for instance *The US Pesticide Illness Surveillance Program (PISP)* in California is actually derived from to the SENSOR-Pesticides Program (previously described as an example of a sentinel system) and uses the case definition and standardise format of assessment of reported cases, including

a detailed investigation of exposure and work-relatedness, as implemented in SENSOR. In this way, the PISP database of reported cases provides the means to identify high-risk situations warranting further action to implement additional Californian restrictions on pesticide use. This is a good example of how a public health system can be used for prevention and policy recommendations.

To summarise, public health monitoring systems aimed at workers and non-workers can provide two types of data: 1) those more subjective, reflecting workers' experience and self-assessment, suitable as a complementary source of information; 2) and those with higher quality control standards, reflecting data on specific groups of diseases, more suitable for prevention and policy recommendations. In order to illustrate how the first type of data is used in practice, the two nationwide surveys are described in-depth in the next section.

Table 12. Main characteristics of public health systems described in the literature review

Country (start date)	System	Organisation maintaining the system	Methods of data collection	Exposure assessment	Work-relatedness evaluation	Follow-up of new/emerging risks (yes/no); usage of data for dissemination/prevention
United Kingdom (2001)	Self-reported work-related illness (SWI) survey (module of the Labour Force Survey)	No record	Data collection over 3 months through interviews with workers who are randomly selected	Described by reporter	No evaluation (survey is based on self-perception of workers)	No; no record
Ireland (1997)	Quarterly National Household Survey (QNHS)	Central Statistics Office (CSO)	Data collection over 3 months through interviews with workers who are randomly selected	Described by reporter	No evaluation (survey is based on self-perception of workers)	No; aggregate table given to the HSA and microdata generated for research purposes
France (1998)	French National Mesothelioma Surveillance Program (PNSM)	French Institute for Public Health Surveillance (InVS)	Voluntary reporting by OH physicians, pathologists, pneumologists, oncologists	Described by reporter	InVS experts	Yes; dissemination through national and international papers/symposia, agency report
France (2002)	Program for Surveillance of Musculoskeletal Disorders	InVS	Voluntary reporting by occupational physicians, surgeons, neurophysiologists	Described by the reporting party	InVS experts	No record; dissemination through website
USA – California	Pesticide Illness Surveillance Program (PISP)	California Department of Pesticide Regulation (CDPR)	Obligatory reporting by physicians and review of illness reports submitted to state workers' compensation system, poison control centres (PCCs) and other government agencies	Described by reporting party and additionally verified	County agricultural commissioners; commissioners' investigation reports are reviewed by PISP staff	No record; PISP database provides means to identify high-risk situations warranting CDPR action to implement additional California restrictions on pesticide use

3.4.1 Labour Force Surveys (United Kingdom and Ireland)

The EU Labour Force Survey (EU-LFS) is the largest European household sample survey, providing quarterly and annual data on labour participation of people aged 15 and over and on persons outside the labour force. It covers residents in private households (excluding conscripts) according to labour status. The EU-LFS currently covers 33 (participating) countries, providing Eurostat with data from national labour force surveys: the 28 Member States of the European Union, three EFTA countries (Iceland, Norway and Switzerland), and two EU candidate countries, namely the former Yugoslav Republic of Macedonia and Turkey.

The LFSs of the United Kingdom and Ireland both have modules for collecting information on work-related ill health. These surveys are categorised in the literature review as active surveillance systems. The two nationwide surveys have similar designs and their main purpose is to estimate the incidence and prevalence of both work-related injuries and WRDs.

The LFS uses a rotational sampling design, whereby a household, once initially selected for interview, is retained in the sample for a total of five consecutive quarters. The interviews are scheduled exactly 13 weeks apart, so that the fifth interview takes place one year from the first. The main reasons for using a rotating sample design are:

- The precision of estimates of change over time is improved when there is overlap in the sample. Thus, better estimates of quarter-on-quarter and quarter-on-same-quarter-a-year-ago can be produced with this wave pattern.
- Longitudinal datasets can be produced, which may be used for analysis of gross change (that is change in individuals' circumstances).

The same number of Wave 1 (new) addresses are selected each quarter. So, in any given quarter, about one-fifth of the addresses in the entire sample are in Wave 1, one-fifth in Wave 2 and so on. Thus, between any two consecutive quarters, about 80 % of the selected addresses are in common.

Labour Force Survey United Kingdom: Self-reported Work-related Illness (SWI)

- **System's aim and objectives**

The United Kingdom LFS is a large nationally representative survey of private households, which currently consists of around 38,000 responding households each quarter. It is designed, developed and managed by the Office for National Statistics in Great Britain, and in Northern Ireland by the Department of Finance and Personnel on behalf of the Department of Enterprise, Trade and Investment. The Office for National Statistics is the provider of LFS data, but the analysis and interpretation of these data published on the HSE website are the sole responsibility of HSE.

Four different sampling frames are used in the United Kingdom LFS (ONS, 2015). Great Britain is split into two areas: south of the Caledonian Canal, comprising all of England, Wales and most of Scotland; and north of the Caledonian Canal in Scotland. Northern Ireland has its own sampling frame. A separate list of National Health Service accommodation in Great Britain is maintained. The Wave 1 sample is selected by first ordering the sampling frames geographically, and then drawing the selection systematically (that is, with a fixed interval). For the most part, the LFS may be regarded as a single-stage sample of households each quarter. However, the geographical ordering of the frame implicitly stratifies the sample, ensuring a geographical spread of addresses. Since all adults within a household are sampled, the person-level survey may be regarded (mainly) as a one-stage cluster sample of people, in which the households are the clusters (or primary sampling units).

Most households are interviewed face to face for their first inclusion in the survey, and by telephone, if possible, during quarterly interviews thereafter. Respondents are encouraged to provide a telephone number and agree to interviews in subsequent waves by the telephone.

The HSE commissions annual questions in the LFS to gain a view of work-related illness and workplace injury from the perceptions of individuals. The HSE questions are included in two survey modules: the 'workplace injury survey' module and the **'self-reported work-related illness (SWI**) survey' module. Each questionnaire module has a core set of questions with a small number of additional questions that are asked periodically. Although information is also collected in Northern Ireland, this information is not routinely published, since HSE's jurisdiction is restricted to Great Britain only.

- **Description of the system workflow**

The SWI survey module was annually included in the LFS from 2003-04 to 2011-12, and periodically before then (the earliest results are from 1990, although results prior to 2001-02 are not directly comparable with later time periods) (HSE, no date). The module was suspended for one year in 2012-13, but in 2013-14 annual data collection was resumed. This survey module provides an indication of the annual prevalence (including long-standing as well as new cases) and incidence (new cases) of work-related illness and its distribution by major disease groups, and a range of demographic and employment-related variables. The SWI survey module has, since 2003-04 (and periodically prior to that), also provided information on the number of working days lost to work-related ill health, with the exception of 2012-13, when no ill health data were collected.

Reporting parties

Data are collected in three-month periods, through interviews with workers (randomly selected). The SWI gathers information on people who have conditions that they believe to have been caused or made worse by their current or past work.

Reporting mechanisms

During these interviews, workers can report any health problem they perceive as work related. As individuals are asked to self-report any work-related illness they believe they have suffered over the previous 12 months, the responses obviously depend on lay people's perceptions of medical matters. Although such perceptions are of interest and are important in their own right, they cannot be taken as a precise measure of the 'true' extent of work-related illness. People's beliefs may be mistaken: they may ascribe the cause of illness to work when there is no such link, and may fail to recognise a link with working conditions when there is one, for instance because of the possible multifactorial nature of ill health or the delay between exposure and ill health (which can be several decades in the case of cancer). Even with these discrepancies, individuals are uniquely well placed to assess the role that work factors play in their illness. They are in a position to follow in detail how particular aspects of work have impacted them and to observe their bodies' responses. Research (HSE, 2013) indicates a reasonable degree of reliability in self-reports of work-related ill health in the LFS, and, when sensibly interpreted, such surveys provide valid and relevant information that is not available from other sources.

Work-relatedness evaluation

As SWI provides no work-relatedness evaluation, its data 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.

Communication

There is no specific communication with the reporting workers.

Data storage

No information is available on the way data are stored.

- **Dissemination of findings**

Published reports can be accessed through the publications/release schedule at:

www.hse.gov.uk/statistics/publications/swi.htm.

- **Financial aspects**

No information is available on financial aspects.

- **Usage of data**

A number of readily available tables can be accessed through the HSE statistics index of tables at www.hse.gov.uk/statistics/lfs/index.htm. Since estimates derived from the LFS are based on a sample (rather than the full population), they are subject to a margin of error. The main factor that determines the width of an estimates margin is the number of sample cases on which the estimate is based. In published reports and tables, the sampling errors are often expressed as 95 % confidence intervals.

Examples of data usage for informing policy and prevention

The LFS provides the preferred estimate of the scale of occupationally related stress as well as work-related musculoskeletal disorders (WRMSDs) in Great Britain. HSE's current research suggests that there is a high correlation in respect of attribution to work between self-reported and medically diagnosed stress, and between self-reported and medically diagnosed musculoskeletal disorders (MSDs). As the LFS questions have been asked annually for the last 10 years, the LFS is the best source for trend information.

Work-related musculoskeletal disorder statistics

The latest estimates from the LFS (2016) show the following in Great Britain (HSE, 2016a).

- The total number of WRMSD cases (prevalence) in 2015-16 was 539,000 out of a total of 1,311,000 of all work-related illnesses, 41 % of the total.
- The number of new cases of WRMSDs (incidence) in 2015-16 was 176,000, an incidence rate of 550 cases per 100,000 people. This is not significantly different from that of the previous year, and the rate has been broadly flat for the last five years.
- An estimated 8.8 million working days were lost to WRMSDs, an average of 16 days lost for each case. This is not significantly different from the previous year. Work-related MSDs account for 34 % of all working days lost to work-related ill health.
- Agriculture, forestry and fishing, construction, transportation and storage, and human health and social work are industries with significantly higher rates of WRMSDs than those of other industries.
- The occupations that have statistically significantly higher rates of WRMSDs than average are those in skilled trades and process and machine operatives.

Work-related stress, anxiety and depression statistics

The latest LFS estimates show the following in Great Britain (HSE, 2016b).

- The total number of cases of work-related stress, anxiety or depression (SAD) in 2015-16 was 488,000, a prevalence rate of 1,510 per 100,000 workers.
- The number of new cases was 224,000, an incidence rate of 690 per 100,000 workers. The estimated number and rate have remained broadly flat for over a decade.
- The total number of working days lost to this condition in 2015-16 was 11.7 million. This equated to an average of 23.9 days lost per case. Working days lost per worker showed a generally downward trend up to around 2009-10, since which the rate has been broadly flat.
- In 2015-16, stress accounted for 37 % of all work-related ill health cases and 45 % of all working days lost to ill health.
- Stress is more prevalent in public service industries such as education, health and social care, and public administration and defence.
- By occupation, jobs that are common across public service industries (such as healthcare workers, teaching professionals, and business, media and public service professionals) show higher levels of stress than all jobs.

- The main work factors cited by respondents as causing SAD (LFS) were workload pressures, including tight deadlines, too much responsibility and a lack of managerial support.

Examples of data usage for detection of new/emerging WRDs

There are no specific examples of data use for detecting new/emerging risks available.

Labour Force Surveys Ireland: Quarterly National Household Survey (QNHS)

▪ System´s aims and objectives

The QNHS began in September 1997, replacing the annual LFS. The annual LFS was conducted each year in April and involved the completion of a paper (written) questionnaire in each of the sample households. It was carried out in Ireland by the Central Statistics Office (CSO) from 1975 to 1997. Demand for more frequent and more comprehensive information had been growing. In particular, there was a strong need for data on employment and unemployment on a quarterly, rather than annual, basis. In response to these growing demands, the CSO replaced the LFS with the QNHS. The survey meets the requirements of Council Regulation (EC) No 577/98, which call for the introduction of a quarterly LFS in EU Member States.

The QNHS survey (formerly known as the Irish module of the LFS) is a large-scale nationwide survey carried out by the CSO of Ireland, and covers 2,000 households weekly. Each quarter, in addition to the core labour market information, the QNHS includes one or more social questionnaires, the subject of which is decided by the National Statistics Board. Topics covered to date include housing/housing quality, crime and victimisation, recycling, travel to work and health.

The annual special module on work-related accidents and illness is added to the regular QNHS in one quarter of each year, usually in Q1. The module on work-related accidents and illness is restricted to people who are currently in employment (or temporarily out of it), and is divided into two sections: one to collect information on work-related injury and the other on work-related illness. The questions refer only to illnesses that have occurred over the previous 12 months, and specific information is collected on the experience of illness, such as the number of days of absence and the type of illness.

▪ Description of the system workflow

Reporting parties

200 questions on a range of topics including the respondents' economic status (employed, unemployed, not in the labour force), industry of employment, nationality, employment status, occupation, education level, length of time unemployed and so on. Not all respondents are asked all of the questions, as the questions are filtered on the basis of the interviewees' responses. Additional questions on a particular topic are included for modules that are run in individual quarters. The QNHS and module questionnaires are available on the CSO website: http://www.cso.ie/en/qnhs/qnhsmethodology/.

Work-relatedness evaluation

As a household survey, the QNHS relies on workers themselves identifying if they have Informants are selected from all adult employees (aged 15 and older) who have worked in the targeted 12 months occupying private dwellings (households). Only those who are employed at the time of the survey or who are not currently employed but have worked during the 12-month reference period are asked to complete the module on workplace illness and injury.

Reporting mechanisms

The QNHS collects data on work-related ill health on the basis of the individuals' perceptions of their illness, and, if their illness has not been certified, their perception of its relatedness to work. A field force, comprising 10 field coordinators and 100 field interviewers, interviews households. Participation in the survey is voluntary. Individuals are asked if they have suffered any illnesses or disabilities in the preceding 12 months that they believe were caused or aggravated by their work, and to describe their most recent work-related illness. Interviews are carried out in the respondent's home and are not in any way connected to the workplace or the employer. Therefore, respondents have no reason to fear

sanctions from their employer about any statement they might make about their experience of injury or illness at the workplace. Moreover, the employer can neither contradict nor confirm the information.

All the information collected from each respondent concerning injury or illness, as well as the attribution of the cause, is based on his or her self-identification and description. The illness may or may not have been assessed by a doctor. Often, during household interviews, some household members were not present to answer questions, and in these cases other household members answered on their behalf (interview done by proxy).

The QNHS questionnaire (http://www.cso.ie/en/media/csoie/qnhs/documents/ICThouse2016.pdf) contains approximately experienced an illness that is related to work. It is also up to the worker to classify the type of illness into a broad category. The QNHS provides no work-relatedness evaluation, so it is inadequate as a means of monitoring new/emerging WRDs. However, it provides information on WRDs from the workers' perspective, which is a valuable complementary source of information to other monitoring schemes.

Communication

There is no specific communication with the reporting workers.

Data storage

No information is available on the way data are stored.

- **Dissemination of findings**

Users of the QNHS data are:

- the European Union/Eurostat, asthe Irish QNHS module was part of an EU-wide LFS survey on work-related illness (and injury) in 2007 and 2013;
- government departments (Department of the Taoiseach – who is the head of government or prime minister of Ireland – Department of Finance, Department of Jobs, Enterprise and Innovation, Department of Social Protection, Department of Education and so on);
- SOLAS (formerly FÁS), the national skills training agency;
- other research centres and universities involved in labour market research (for example, an aggregate table is given to the HSA and microdata are generated for research purposes);
- the national media;
- the general public.

- **Financial aspects**

No information is available on financial aspects

- **Usage of data**

The annual module on work-related injuries and illnesses provides information, published in the HSA annual statistics publication, on the following (Drummond, 2007; HSA & ESRI, 2015):

- number and rate, per 1,000 workers, of people suffering illness;
- rate of illness requiring more than three days of absence;
- numbers employed in each economic sector;
- numbers and rates of illness (total and requiring more than days of absence) in each economic sector;
- number and rate of illness by economic sector and gender;
- rates of illness by age group;
- illness by occupation.

Table 13. Ireland: trends in numbers of any work-related injury and illness, 2001-2012

Year	Injuries (0+ days)	Illness (0+ days)
2001	46,500	33,603
2002	43,457	38,490
2003	45,730	40,523
2004	57,528	59,836
2005	57,765	64,430
2006	58,615	71,675
2007	64,206	59,273
2008	41,994	40,874
2009	32,010	30,593
2010	40,584	38,703
2011	40,097	49,436
2012	35,001	51,210

Source: QNHS microdata, weighted to reflect population statistics.

Table 14. Ireland: individuals aged 15 years and over in employment who suffered work-related injuries and work-related diseases in the preceding 12 months, December–February, 2003-2007 (in thousands)

Work-related injury		2003	2004	2005	2006	2007
All individuals	In employment	1,779.5	1,833.0	1,910.8	2,004.8	2,081.3
	Suffered an injury	48.3	56.0	53.2	57.8	58.6
	Injury rate	2.7	3.1	2.8	2.9	2.8
Male	In employment	1,035.5	1,066.1	1,102.2	1,158.9	1,194.4
	Suffered an injury	32.8	41.6	37.3	44.4	44.2
	Injury rate	3.2	3.9	3.4	3.8	3.7
Female	In employment	744.0	767.0	808.6	845.9	886.9
	Suffered an injury	15.5	14.4	15.9	13.3	14.4
	Injury rate	2.1	1.9	2.0	1.6	1.6

Work-related illness		2003	2004	2005	2006	2007
All individuals	In employment	1,779.5	1,833.0	1,910.8	2,004.8	2,081.3
	Suffered an illness	45.5	47.9	58.9	64.4	71.7
	Illness rate	*2.6*	*2.6*	*3.1*	*3.2*	*3.4*
Male	In employment	1,035.5	1,066.1	1,102.2	1,158.9	1,194.4
	Suffered an illness	29.2	32.3	35.9	41.2	44.3
	Illness rate	*2.8*	*3.0*	*3.3*	*3.6*	*3.7*
Female	In employment	744.0	767.0	808.6	845.9	886.9
	Suffered an illness	16.3	15.6	23.0	23.2	27.3
	Illness rate	*2.2*	*2.0*	*2.8*	*2.7*	*3.1*

Although accident and ill health data are important, some caution should be taken in their use, as they are a direct indicator of safety and health performance.

- Most organisations have too few accidents resulting in injury or cases of work-related ill health to distinguish real trends from random effects.
- If more work is done by the same number of people in the same time, increased workload alone may account for an increase in accident rates.
- The length of absence from work attributed to injury or work-related ill health may be influenced by factors other than the severity of injury or occupational ill health. Such factors may include poor morale, monotonous work, stressful working conditions, poor management/employee relations, and local advice or traditions.
- Although accidents are often under-reported, they are occasionally also over-reported. Levels of reporting can change. They may improve as a result of increased workforce awareness, and better reporting and recording systems.
- A time delay may occur between safety and health management system failures and harmful effects. Moreover, many ODs have long latency periods. Management should not wait for harm to occur before judging whether or not safety and health management systems are working (http://www.hsa.ie/eng/Topics/Managing_Health_and_Safety/Safety_and_Health_Management_Systems/).

Examples of data usage for informing policy and prevention

Work-Related Musculoskeletal Disorders and Stress, Anxiety and Depression (SAD) in Ireland: Evidence from the QNHS, 2002-2013

This is the title of a study (Russell, Maître & Watson, 2016) that addresses two main questions: (1) How did trends in MSD and SAD develop as the Irish economy went through a period of economic growth (2002-2007), recession (2008-2011) and early recovery (2012-2013)? (2) What are the contributing factors, and socio-demographic and work characteristics, that increase the risk of MSD and SAD?

The report covers a period of exceptional change in the Irish economy, which went from strong employment growth to deep recession, with a peak of 2,169,000 people in employment in 2007 and a low of 1,825,000 in 2012. The following main features of work-related MSD and SAD were observed during this period:

- The illness rate rose from a rate of 22 per 1,000 workers in 2002-2003 to a peak of 35 per 1,000 workers in 2006, before falling to a low of 15 per 1,000 workers in 2009.
- MSD rates doubled over the period 2002-2006, from 11 per 1,000 workers to 20 per 1,000 workers. It then fell during the recession to a low of 7 per 1,000 workers in 2009, before rising again to reach a rate of 14 per 1,000 in 2013. SAD rates did not vary very much over the same period, averaging about 4 per 1,000 workers, with a peak in 2012 due to changes in question wording.
- MSD rates were higher among male workers than among female workers during the period of economic growth. Since the beginning of the recession, the gender gap has narrowed. SAD rates have been higher among female workers than among male workers over the period but the gender gap is narrower for MSD.

More specifically in relation to the sectors of economic activity, the following was observed:

- There are strong variations in the prevalence of self-reported work-related illness across economic sectors and by type of illness. MSD is reported by more workers in the construction, agriculture and health services sectors.
- Workers in the education sector have a higher prevalence of self-reported SAD, followed by those in health, public administration, transport and other services. Agriculture, construction, industry, retail and accommodation/food all have significantly lower prevalences of self-reported SAD than the reference group (other services).

In relation to working patterns, the following was observed:

- Long weekly hours are associated with an increased risk of SAD.
- MSDs were not strongly linked to working hours, except that those working 40-49 hours were at a lower risk than those working under 30 hours.
- Both shift work and night work are associated with a greater risk of MSD: shift workers are 1.5 times more likely and night workers 1.2 times more likely to experience MSD than other workers. Shift workers are also 1.3 times more likely to report SAD than other workers.

Lessons for policy

This report identifies both individual and workplace factors that are associated with higher risks of MSD and SAD. From these, some lessons for policy can be drawn that may contribute to reducing work-related illness. Because of the cross-sectional nature of the data, it is not possible to establish causality in the associations found, and conclusions should be interpreted in the light of these data limitations.

- As the workforce is ageing and the prevalence of MSD is higher among older workers, there is a need to adapt the working conditions of older workers to prevent and minimise the effects of MSD. This could involve changing the nature of the tasks of older workers, adjusting working hours and scheduling, or assisting them with equipment when possible.

- Particular attention should be paid to prevention, monitoring and training in firms and organisations in which workers operate on a shift work or night work basis, and where it is necessary for the organisation to operate in this manner.

- It is important to maintain a high level of health surveillance in sectors with a traditionally greater risk of MSD, such as the agriculture and construction sectors.

With the increasing proportion of women in the workforce and the greater prevalence of SAD among female workers, greater attention should be paid to these types of work-related risks. Particular attention should be paid to the education sector, which has the highest risk of SAD illnesses.

Examples of data usage for detection of new/emerging WRDs

No specific examples of data use for detecting new/emerging risks are available.

4 Discussion of findings

4.1 Drivers and obstacles of the systems

As one of the main purposes of this project was to identify systems suitable for the detection of new/emerging WRDs, the drivers for and obstacles to the implementation of such systems were specifically discussed in the interviews with stakeholders carried out as part of this project (see 2.3.2) and at the expert workshop held in May 2017 (see section 2.4). The outcome of these discussions is presented in the following sections.

4.1.1 Visibility of the system

The issue of poor system visibility was a limitation encountered already during the literature search performed earlier in the project as part of Task 1. Indeed, some of these systems (such as the French GAST, or the OHSP Navarra in Spain) are **poorly described in the literature** or are presented in articles/reports only in the language of the country where they are operative, which also limits broader understanding of them. In order to obtain information on these systems, a thorough search had to be performed through websites and other sources available in the language of the country, often translating them to gain all the necessary information. Regardless of the quality of these systems, invisibility may be an obstacle to their impact in OSH and therefore to their sustainability. One possible way in which to **raise awareness of the existence of these systems** is the publication of results and their dissemination through reports/newsletters targeted at physicians, such as the work-related and injury newsletter published by the NLI a few times per year (one to three times) based on data obtained from the RAS in Norway. Another possibility is to provide open access to case reports stored in a database. This approach is implemented in the US HHE system, in which all the relevant data are also published on the NIOSH website. In addition, success stories should be shared, especially with regard to successful examples of the impact of such systems on prevention of WRDs and on evidence-based policies. Sharing success stories not only makes the system visible but also demonstrates its added value, which is a motivating factor for reporting parties as well as for stakeholders to make resources available for the implementation of such systems. Therefore, visibility was reckoned to be a key driver for the impact, success and sustainability of a system.

4.1.2 Commitment of reporting parties

One of the main issues discussed by the interviewees was the motivation of the reporting parties to report cases to the system. As physicians are the main reporting parties in most of the systems described (except for SENSOR-Pesticides and the HHE in the USA, and the LFS in the United Kingdom and Ireland), the problem of engaging physicians to report was linked with the increasing work demands and time constraints in their daily clinical practice, which hardly allow any additional activities.

The stakeholders interviewed suggested several possible ways to help cope with this obstacle. They all agreed that **simplification of the reporting procedure** is essential. THOR is an example of a system where measures are implemented to facilitate and increase reporting. Indeed, THOR allows several options for simplifying reporting, such as the delegation of the reporting task to nurses or to a group leader who reports for a group of physicians. In addition, THOR experts mentioned the possibility of developing a reporting application in the future. Other systems, such as RAS and HHE, developed a simplified reporting procedure with no burden of proof necessary before reporting. Similarly, reporting cases to the SENSOR-Pesticides system has been simplified by enabling it to be performed through a telephone call to a poison control centre, which is in charge of the subsequent data flow. Nevertheless, some of the SENSOR stakeholders still felt that this was not sufficient, and suggested **automating** the initial reporting step as a possible solution.

Another possible way to motivate physicians to report is to provide different means of feedback so that reporting becomes **two-way communication**. As explained by one of the reporting parties interviewed, this emphasises the **importance of a participatory approach**, which makes the physicians feel that

they can also get something back from it. Feedback options include communication between reporting parties and assessors on the work-relatedness evaluation procedure, the distribution of reports to all the participating physicians, and meetings to discuss the different aspects of the system. Another interesting example is THOR's implementation of the web-based platform EELAB, which provides reporting parties with constant learning opportunities and the possibility of continuing professional development in return for reporting. The Norwegian RAS system also provides feedback to reporting parties, emphasising the positive effects of reporting on patients and its contribution to prevention. In addition, this system provides a financial reward in return for each accepted report. However, although this may have a motivating effect, this approach is often hard to implement because of financial limitations.

Interestingly, the stakeholders of only two systems, MALPROF and SUVA, did not point out the motivation of reporting parties as a major obstacle. With regard to MALPROF, this can be linked to **the existence of legislation** that demands that healthcare providers report all suspected WRDs to the authorities. Indeed, the interviewees from Italy emphasised that one of the drivers of MALPROF is the fact that the system is built on the existing network of OH providers, and that reporting to the system is mandatory by law. However, in some states of the USA, even the implementation of laws on the mandatory reporting of pesticide-related health risks did not solve the problem of under-reporting to SENSOR-Pesticides. Therefore, OSH reporting laws might not be a solution per se, but they may provide a basis for developing a strong network of reporting parties.

The higher motivation to report to SUVA may be explained by the specific structure of the system, which is based on the national compensation system (Type 1 of the typology). Whereas the other groups of systems (non-compensation-based systems and sentinel systems) are dependent on voluntary reporting by physicians, reporting to SUVA is mainly driven by the need for insurance services provided by this system.

4.1.3 Exposure assessment

Another important issue raised in the discussions on the systems' obstacles was the lack of adequate exposure assessment. Many interviewees emphasised the importance of this step in the data collection and work-relatedness evaluation procedures, especially in terms of identifying potential new/emerging WRDs.

Exposure assessment is essential in monitoring systems for WRDs, whether they are used for prevention or compensation. Not only the chemical agent responsible but also the level, duration and pattern of exposure must be assessed and documented. Whether the exposure is harmful or not depends on level and duration. It is not necessary to take measurements in every case. If the working procedure and possible prevention measures are documented, documented measurements from similar workplaces can be used.

Establishing a clear causal relationship with work is crucial for the acknowledgment of the new health risks that arise from or are aggravated by working conditions. Bearing in mind that the alert and sentinel approaches described in this report were chosen as examples of good practice in monitoring new WRDs, exposure assessment was a mandatory step in most of them. However, there were still some differences in the way exposure was assessed in different systems.

The lack of exposure assessment was seen as one of the main issues in terms of data quality and obstacles to some non-compensation-based systems such as THOR and MALPROF. In THOR, this issue has already been tackled, as researchers are working on **including exposure description in the reporting procedure**. This additional information would include the duration of exposure, the steps taken to quantify it and the actions taken to reduce exposure. However, MALPROF stakeholders also pointed out concerns that including exposure description in the reporting procedure could result in a great amount of missing data, as the MALPROF system is not based on reporting by OH physicians, who are more competent in providing exposure information. Indeed, the French RNV3P system and the Dutch and Belgian SIGNAAL (sentinel system) are based on reporting by OH physicians and both have implemented exposure description as a mandatory part of case reporting.

The gaps in exposure assessment could also be filled in after reporting, in the evaluation step performed by experts. For instance, OH experts in SIGNAAL contact reporting parties if the information

on exposure in the reporting form is insufficient for the work-relatedness evaluation. Similarly, experts in the Norwegian RAS system and OHSP Navarra often contact employers for additional information regarding the exposure of workers. Another example is RNV3P, in which experts may contact reporting parties to clarify any doubts regarding the exposure in a specific case.

Another strong point of RNV3P in terms of exposure assessment is its specific thesaurus, which is used in France. This provides **hierarchical codes for all types of exposures**. Thus, if isocyanates, for instance, were identified as the chemical exposure, the codes would also specify if they were present in glues, paints, insulation foam and so on. Similarly, in SENSOR-Pesticides, the collected data are organised using standardised variables, including those regarding exposure: type of exposure, the person's activity at the time of exposure, the protective equipment used and so on. However, the organisation of variables takes place in the screening phase, which is performed by experts working in state health departments. Another system in which exposure assessment is clearly structured is EpiNano. In this system, multidisciplinary teams perform workplace inspections using a standardised tool for exposure investigation. Therefore, structured coding of exposure data by experts could be a possible approach to the issue of exposure data assessment and quality. However, this may be more easily implemented in systems with a specific scope, such as SENSOR-Pesticides and EpiNano, which focus on a specific type of exposure, thus enabling the assessment to be clearly structured.

Finally, exposure assessment in SUVA is closely related to its link with compensation. Within this system, **workplace inspections** are performed in order to gather detailed data on exposure and include its objective measurements, when possible. However, workplace inspections are not performed systematically. This might lead to unequal quality of exposure data, a physician's description of an exposure may differ significantly from the findings of an on-site assessment.

The greatest challenge in practice is to detect relationships between exposures and diseases with a long latency (for example cancers and other long-latency diseases caused by exposures to dangerous substances). Systems that document such WRDs and related exposures can become important for the derivation of dose-response-relationships; see for example the project of the Partnership for European Research in Occupational Safety and Health on dose-response relationships for selected chemical substances (http://www.perosh.eu/research-projects/perosh-projects/dose-response-relationships-drr-for-selected-chemical-substances/). The crucial condition is an adequate exposure description.

4.1.4 Standardisation and quality control of collected data

The standardisation and coding of gathered data is important not only for structured exposure information, but also to improve the overall quality control. During the interviews, the experts emphasised the importance of standardising data for the purpose of data quality improvement, as well as to enable the comparison of data collected at national and international levels. The systems described provide several examples of how standardisation can be implemented in practice. While coding for occupation and industry is performed in all the systems analysed, some systems also implement interesting examples of additional measures to improve the standardisation of data.

One of the most representative examples in terms of standardisation of data is certainly SENSOR-Pesticides. It begins with a clear definition of reportable cases and strictly defined criteria for defining a case as work related. Moreover, all data collected on each case are organised using the variables defined in the screening phase. All participating states are encouraged to use standardised formats for these variables. However, this system has a narrow scope, as it focuses specifically on cases related to pesticide exposure, whereas it is harder to implement such a clear case definition and determination of variables in systems that monitor all types of WRDs.

In addition, NIOSH organises **quality control exercises to improve the quality of coding** within SENSOR-Pesticides. Twice a year, a series of scenarios is sent to different states for coding. After the answers are collected and evaluated, SENSOR experts discuss the findings in a webinar or workshop. Similarly, OHSP Navarra provides an operative case definition and criteria for each type of work-related disease. Their interpretation can be discussed and adjusted in annual follow-up meetings.

Another good example of both standardisation and quality control of data is the French RNV3P system. As mentioned in the previous section on exposure assessment, this system uses a specific thesaurus

to clearly specify the types of exposures. **The codes are regularly updated** and follow current OSH trends. So, if a potential new work-related exposure is identified, a corresponding code is added to the thesaurus. This is especially significant for new/emerging risks. In addition, **all the coded data are proofread by a senior expert**. At this stage, an alert is raised if data are missing or are not adequately coded. If the alert concerns minor items, this might be resolved by the senior assessing the case. However, if the alert is major, the report will not be validated or added to the national database. This quality control procedure enables all the data stored in the national database to be of equal quality and indirectly influences the quality of data mining in the database, with the purpose of identifying new/emerging WRDs.

The importance of the uniformity of data at the national level was also highlighted by one of MALPROF's experts, who saw the lack of standardised reporting at the national level as one of the drawbacks of the system. However, this was partly compensated by the quality control intrinsic to the structure of the system itself. Indeed, the quality of the data collected is the starting point for work-relatedness evaluation, as the assessing physicians from ASL clearly indicate whether or not the gathered information is adequate to provide an insight into the causal relationship with work. This was considered one of the strong points of the system during the interviews.

4.1.5 Improving data for policy

Of the systems described in this report, many were **developed with the aim of improving the data on WRDs**, mostly from the group of non-compensation-based systems (THOR, RNV3P, OHSP Navarra and so on). For instance, in Spain, OHSP Navarra was developed with the aim of minimising the under-reporting of WRDs. Indeed, data gathered by the system revealed that the number of reported WRDs in Navarre was six times higher than the number reported to the national compensation-based system, revealing serious under-reporting in the rest of Spain.

Some public health monitoring systems, such as the LFS, were implemented with the aim of providing statistical data on incidences of and trends in WRD. The LFS uses the widest definition of work-related illness and workplace injuries in order to collect data based on workers' self-assessment of their conditions and health status. This system produces quarterly data on the overall number of workers and special modules, including information on the number of workers with work-related 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 sectorial breakdown for the data.

Some systems, such as the United Kingdom's THOR, have **developed a variety of sophisticated statistical methods** that take into account and adjust for the factors that might influence the 'true' incidences/trends (variation in number of reporting parties, reporter fatigue and so on). Their key objective is to determine nationally representative and statistically robust estimates of disease incidence. To do so (and to compare disease incidence meaningfully between different locations, jobs, industries and so on), various statistical methods have been developed, which take into account the differences in the underlying populations (denominators) from which the cases are drawn. This plays a significant role in providing a more realistic image of work-related health problems and in complementing official OD figures, which are often minimised because of under-reporting. One of the most significant recent methodological advances implemented by THOR has been the use of MLMs to investigate the change in disease incidence over time. This approach enables factors such as variation in the number of physicians reporting to THOR, seasonal patterns in reporting, or a decrease in reporting over time because of reporter fatigue to be taken into account.

The two United Kingdom systems – THOR and the LFS – have been designed to **provide complementary data and are triangulated at the national level** in order to improve the statistics used for the development of preventive actions and policies. These two systems are suitable for different purposes: whereas the LFS provides more sensitive data with a low threshold for reporting, reporting within the THOR system is more structured and standardised and produces a more specific signal. These signals are integrated in communication with the HSE and used for different purposes.

4.1.6 Awareness and detection of new/emerging WRDs

One of the main conditions for capturing new WRDs is that the reporting parties who can identify them are aware of these emerging diseases. THOR has used an innovative approach to raise awareness of new WRDs, **EELAB** (described in section 3.2.4 of this report). Through the learning opportunities provided by EELAB, reporting parties can also obtain information on emerging work-related health risks and diseases. They can read about cases previously identified and learn how to recognise similar cases. In addition, case reports describing new WRDs have become a regular part of the quarterly reports that are sent to the reporting physicians from all the schemes.

Another step taken in order to identify new WRDs is the development of the **THOR-EXTRA reporting scheme**, designed specifically for capturing new diseases that have not been previously identified or related to work. This scheme enables reporting parties from all the THOR schemes to submit cases to be further evaluated by OH experts.

SIGNAAL is a representative example of a system **specifically designed to detect new/emerging WRDs**. Therefore, all the aspects of this system are adapted for this purpose, from reporting to the evaluation of work-relatedness and the follow-up of cases. The online reporting platform is designed to cover a set of questions that can enable better understanding of the causal relationship with work (description of job tasks, information regarding exposure, results of diagnostic testing, actions already taken and so on). In addition, the reporting parties can also add relevant documents (such as pictures of a skin lesion). Importantly, the reporting physicians do not have to establish a clear diagnosis; it is enough that they describe the symptoms, which are then considered for further investigation. Another strong point of this system is that **a team of experts in the field of new/emerging WRDs performs the work-relatedness evaluation**. All the reported cases are discussed among the experts, and the final decision on work-relatedness results from consensus.

The French GAST system and HHE in the USA were also specifically designed to investigate unusual health events at work. Both systems have **a low reporting threshold**: the occurrence of a cluster of symptoms/diseases (GAST) or at least three similar cases at the same workplace (HHE) are enough to trigger investigation and preventive actions. In addition, the reporting parties in these systems are employees (HHE) or any OH actor in charge of prevention, or a witness of the event (GAST). The work-relatedness evaluation is performed by multidisciplinary teams. This approach has resulted in the detection and prevention of several new/emerging WRDs, such as a cluster of renal cancer in a chemical plant related to exposure to chloracetal C5, cases of severe silicosis associated with reconstituted stones or bronchiolitis obliterans in a microwave popcorn plant.

Another system designed to detect new and emerging WRDs is EpiNano. However, its scope is very specific, **focusing on new and emerging health risks from exposure to nanomaterials**. This system uses a somewhat different approach from all the other systems described, starting from the identification of exposure to monitor potential health problems, which is more similar to an active surveillance approach. The system is relatively new and no new or emerging health risks have been detected so far, but they might be in the next phase of the system development, which is the prospective cohort study aimed at monitoring the possible medium- and long-term health effects of nanomaterial exposure.

The MALPROF system is designed in a way that allows new WRDs to be captured, as well as activity sectors or job titles that are not yet known to be potentially related to ill health. However, this system uses a different approach from that of SIGNAAL. MALPROF does not assess exposure data themselves, but rather **identifies sectors or professional qualifications that are linked to the origin of exposure**. In addition, this system uses specific statistical methods, such as the proportional reporting ratio, that enable the identification of economic sectors that are at high risk of certain WRDs. Therefore, MALPROF seems to be more suitable for identifying new causal relationships between *existing* WRDs and specific jobs/industries than *new* WRDs.

The French RNV3P system implements searches on several levels for cases of new WRDs. As well as reporting by physicians who identify the cases, this system implements some innovative methods such as **data mining and the identification of disproportionality signals in the existing database**, and a **proactive search for cases in response to alerts of new WRDs from other sources** (literature, NIOSH, Modernet). The identification of a signal is further evaluated by an expert group, based on an algorithm containing three dimensions: imputability, seriousness of the case and the frequency of the

occurrence of similar cases in and outside the RNV3P database. Consequently, an emergence signal score is obtained.

Unlike the non-compensation-based systems and sentinel systems previously mentioned, SUVA has **limited ability to detect new/emerging WRDs because of its specific link with compensation**. The main obstacle is the condition of 75 % of work-related causality, which is necessary in order to report a condition that is not on the list of recognised ODs. According to SUVA's stakeholders, this is often very hard to prove in practice, especially in the case of multifactorial diseases such as musculoskeletal disorders or stress-related mental health problems, which are the main work-related diseases. One of the interviewees explained that physicians often decide not to report a disease because of difficulties in establishing the level of work-relatedness causality demanded. However, new/emerging WRDs are sometimes reported by means of personal communication between SUVA's experts, outside the official reporting system. This might trigger further investigation into similar cases and, in the long term, potentially lead to changes in the official list of ODs.

In general, the alert and sentinel approaches in place **do not provide sufficiently population-based signals on specific emerging risks and economic sectors or activities**. For instance, there is little knowledge about the exposures and health effects of some of the main emerging technologies such as nanomaterials and robotics. In order to understand the possible risks and effects associated with these new technologies and ensure timely prevention, there is a need to implement alert and sentinel systems addressing these specific risks. In terms of economic sectors, the focus is still on traditional sectors, such as agriculture and construction, whereas there is a lack of knowledge and investigations in relation to newer sectors such as call centres, the hotel, restaurant and catering sector and IT services.

4.1.7 Different levels of links with prevention through communication between stakeholders

The discussion with the various stakeholders of the systems revealed how data gathered by the system are used in practice for prevention, and identified the specific drivers for and obstacles to implementing these preventive actions. Analysis and comparison of the data derived from the interviews revealed several levels of links with prevention, which could also be specific to the types of systems defined in the typology.

The data in the non-compensation-based systems are mainly used to guide health policies and preventive actions at the national level. This can be linked to the design of these systems, which aims to provide national OSH data that can further be used by the governing bodies for implementing evidence-based preventive campaigns and interventions widely. In this context, the interviewees named **the importance of collaboration with an OSH public body** as the main driver. This is the HSE in the case of THOR, INAIL for the MALPROF system, the French health insurance system for occupational accidents and ODs (CNAMTS) for the French RNV3P system and the NLI for RAS. These systems provide input about incidences and trends in OSH, and identified industries at high risk of a specific WRD, as well as more sophisticated data that take into account variables such as age and gender. These data are then used by the HSE, INAIL and CNAMTS to create national plans for preventing specific WRDs, for determining priorities and work programmes on work-related health, for targeting specific industries at risk and so on.

Most of these non-compensation-based systems, as well as the LFS, which is a public health monitoring system (Type 4 of the typology) are designed to **improve data collection on ODs and WRDs and to complement the existing national monitoring systems of ODs in the country**. So, for instance, the LFS in the United Kingdom provides the widest definition of work-related illness and workplace injuries based on a large, well-established, nationally representative survey. It is also the only described system that uses active surveillance; it monitors the working population on a regular basis in order to retrieve information on the possible work-related health effects (active search for cases). As previously described, data derived from this system are triangulated with those gathered by other systems in the United Kingdom, such as THOR and RIDDOR, which use different reporting sources. This way, data can be compared in order to improve data for policy and detect potential biases in reporting.

Furthermore, the experts in these systems **communicate directly with workplace**. For instance, THOR researchers receive requests for data analysis from different industries and provide feedback, which is then used to support and implement preventive activities in these industries. Similarly, MALPROF data are used to transfer information to local stakeholders such as companies, unions, workers' safety representatives and local authorities. For this purpose, the local and sub-local prevention units (ASLs) are engaged, as the resultant preventive strategies are implemented at a local or regional level. In EpiNano, data gathered though workplace inspections in companies that produce or handle nanoparticles are used to create the on-site technical logbook. This document contains all the essential parameters that can be directly used by companies for risk management purposes, such as implementing the control banding approach to assess and control exposure to engineered nanomaterials in different workstations.

In addition to using the data to identify industries at risk and OSH incidences and trends, the French RNV3P system has **an additional alert and sentinel aspect for identifying new WRDs**, which is similar to a sentinel system. As described before, the experts from the emergence working group decide on the level of alert, depending on the case's emergence score. A level 1 alert involves notifying the RNV3P physicians and recommending that the risk to and protection of the worker be evaluated. Level 2 alerts involve informing other clinicians and other RNV3P partners and a search for similar cases outside the RNV3P network. Level 3 means that wide dissemination at the regional or national level is required, and that other institutions, sanitary security agencies and partners at the national level are alerted in order to suggest and consider preventive actions and regulatory changes. The interviewed stakeholders of this system emphasised the importance of the communication established between different actors and stakeholders in the implementation of preventive activities.

SIGNAAL, SENSOR-Pesticides, HHE and GAST were designed as sentinel systems and therefore **provide a signal on each reported case**. Within SIGNAAL, the preventive measures are mostly implemented at the company level and generate recommendations to policy-makers to a lesser extent. The team of experts who assess the case decide which kinds of preventive measures are most relevant to that specific case. The limited usage of data for policy recommendation is mainly due to the limited number of reported cases so far, which inhibits further statistical analysis. The stakeholders hope a larger number of reported cases in the future will lead to a greater amount of advice useful for policy-maker more useful advice for policy-makers concerning wider prevention. Similarly, SENSOR has a clearly determined data flow that generates an alert about each identified case, which in turn triggers the necessary preventive actions. In HHE and GAST, multidisciplinary teams perform workplace investigation, during which specific preventive measures are determined for implementation. In addition, experts from HHE conduct **followback activities** with workplaces that have been evaluated. These activities may include a return visit to the workplace to see changes that have been made on the basis of the recommendations provided, and sometimes even repeated exposure and health testing to document the effectiveness of these changes. Therefore, these sentinel systems, as well as the alerting part of RNV3P, are in fact early warning systems that provide timely preventive interventions aimed at individual cases.

In addition, SENSOR has a specific **link with pesticide policy regulations**, also by providing an alert. In this context, SENSOR-Pesticides provides EPA with data on the identified adverse health effects caused by pesticides, which are crucial for the process of re-evaluating new chemicals released onto the market. This way, these potentially harmful health effects can be detected at an early stage of the commercialisation of new substances, and directly affect the evaluation of these new products. This specific role of SENSOR-Pesticides in the overall evaluation of new pesticides is closely linked to the organisation of the SENSOR network. As mentioned before, SENSOR has changed its scope over time and the Pesticides scheme has become more oriented towards public health, using other sources of data collection rather than reports from physicians. Therefore, SENSOR-Pesticides has established support from the public health authorities regarding pesticide regulations (EPA, poison control centres, state departments of agriculture and so on). The SENSOR approach towards policy regulations is specifically adapted for pesticide-related cases, and could hardly be implemented in systems that monitor all types of WRDs. However, the standardised protocol on how to guide pesticide-related programmes, clear case definition and standardised variables could be helpful tools for similarly designed pesticide surveillance programmes in other countries, regardless of potential differences in the public health context.

Although the SUVA reporting system's specific link with compensation might limit the detection of new/emerging WRDs, this is certainly not the case when it comes to prevention. Both medical examinations and workplace inspections after the identification of a WRD trigger timely preventive workplace interventions. Therefore, the driver of this system in terms of prevention is the ability to implement these actions regardless of the compensation aspect. So the scope of SUVA's preventive activities extends far beyond compensation itself, and covers enterprises insured by other insurers, including numerous SMEs. This is also supported by two separate funds: one for compensation purposes and the other exclusively for prevention. **New/emerging work-related health risks and diseases are also in the scope of preventive measures derived from SUVA**. For instance, stress at work, burnout and musculoskeletal disorders have been the focuses of screening in companies and of organisational changes aimed at the reduction and prevention of these health disorders, even though they are hardly accepted for compensation because of their multifactorial nature. Therefore, a strong link with prevention that also tackles new/emerging risks is certainly an aspect that could be considered by compensation-based systems in other countries.

4.1.8 Political and financial support and resources

The issue of financial support inevitably arose in the discussions with the stakeholders. In the case of SUVA, financial support does not seem to be an issue, as it comes from the insurance fund. However, the systems not related to compensation mostly rely on government funding, which is often unstable and insufficient and **depends on the importance placed on OSH by the government**. The financial costs of a system mainly include personnel costs and expenses linked to software maintenance (as all systems are web based), the publication of periodic reports and so on.

The team of OH experts involved in a system usually includes either a small number of experts dedicated to the maintenance of the system within the institutes responsible or a wider network of professionals who occasionally perform assessments and work-relatedness evaluations (for example physicians from the MALPROF ASL centres). In the latter case, stakeholders pointed out that this work is not free of charge and can often be time-consuming and challenging.

Being unable to recruit additional personnel overloads a small team of people who have to maintain the whole system. This may also be reflected in the data quality, as assessments of cases under time constraints are often not performed adequately. Therefore, **financial support is directly linked to the issue of human resources and data quality**. This was illustrated by the SENSOR stakeholders, who pointed out that the states where there is no public funding for SENSOR often report fewer cases, perform less coding and sometimes even drop out of the system. In addition, the lack of human resources can **delay the final decision on work-relatedness and the implementation of prevention measures**.

In cases of lack of resources, an alternative is to put in place **smaller-scale projects that target specific areas of OSH** and to look for further funding from sources interested in this very specific area. Although the experts who maintain the systems are often powerless with regard to these financial issues, the interviewees suggested that **improving the visibility of the systems, of their impact and added value is important to demonstrate to policy-makers the importance of making financial resources available**. It is important to communicate effectively about the emerging WRDs identified and potential solutions, and to share success stories about prevention of WRDs identified by the systems. Efforts should be made to make the business case for a system by sharing and disseminating success stories/best practices, particularly with regard to the successful impact of data gathered by the systems on prevention and policy development, demonstrated by concrete examples.

Ultimately, political will is a key driver to the implementation of an alert and sentinel approach, as was emphasised by the participants in both workshops, and this was reckoned to be influenced by the EU-level policy agenda. The importance of setting the identification of (new) WRDs as a consistent priority at the EU level over time was underlined. Some workshop participants even reckoned legislation a more important driver than funding.

4.1.9 Summary of the main drivers

Table 15 below gives an overview of the main drivers discussed in section 4.1, together with examples of measures to strengthen these drivers and good practice examples taken from the systems analysed in this report that have implemented such measures.

Table 15: Summary of main drivers of systems with regard to typology and means to strengthen them

Driver	Status of the driver depending on the types of systems	Measures to strengthen the driver	Good practice examples
Visibility of system	Insufficient visibility of systems that are based on voluntary participation of physicians (non-compensation-based systems and sentinel systems)	Communication plan that includes raising awareness Publication of results	**RAS** – the data contribute to the content of a quarterly work-related diseases and injury newsletter published by the NLI and targeting physicians **HHE** – public access to database of reports. After presentation at the company concerned (management and employees), the results are published on the NIOSH website
Motivation of reporting parties to participate	Generally poorer motivation of reporting parties in systems that are based on voluntary participation of physicians (non-compensation-based systems and sentinel systems) Less of a problem in compensation-based systems, in which reporting is driven by insurance services	Simplification of reporting procedure Automation of initial reporting step Implementation of laws for mandatory reporting (as it is the case in Italy) Encouraging two-way communication (communication between reporting parties and assessors in work-relatedness evaluation procedure, distribution of reports to all participating physicians, meetings to discuss different aspects of system and so on) Financial incentives for reportingOffering help and expertise to solve unusual and difficult situations	**SIGNAAL, OHSP Navarra** – simple online platform for reporting, with clear guidelines for physicians **RAS, HHE, GAST** – low threshold for reporting: in the case of HHE, at the request of employees, with an application submitted by at least three employees sufficient; for GAST, a report can be made by any OH actor in charge of prevention or a witness of the event **THOR** – possibility of delegating reporting task to nurses or group leader, who then reports to group of physicians; implementation of EELAB, which provides feedback to reporting party in form of e-learning, and possibility of obtaining continuing professional development through participation **RAS** – feedback to reporting parties on their contribution to prevention; all physicians reporting cases receive NOK 150 for each accepted report

Driver	Status of the driver depending on the types of systems	Measures to strengthen the driver	Good practice examples
Assessment of exposure and work-relatedness	High-quality exposure assessment in sentinel systems and RNV3P, which require exposure description while reporting and perform another round of quality control Mostly lacking in non-compensation-based systems (except for RNV3P) Exposure assessment is facilitated by workplace inspections in compensation-based systems (SUVA), but the quality of exposure data is unequal, depending on the source (workplace inspections versus only description)	Addition of exposure description to reporting procedure (for example information on duration of exposure, steps taken to quantify it, description of actions taken to reduce exposure), but paying attention to risk of reporting fatigue Integration of data from OH physicians as reporting parties (with more detailed occupational anamnesis) with data coming from other sources (with less detailed exposure assessment) Quality control and coding of exposure data on assessment level performed by experts	**HHE, EpiNano, GAST** – on-site exposure assessment performed by multidisciplinary teams **RNV3P** – specific thesaurus that provides hierarchical codes for all types of exposures **SENSOR** – organisation of exposure data using standardised variables in screening phase, performed by experts working in state health departments **RAS, SIGNAAL, OHSP Navarra** – quality control of exposure data by possible contact with reporting physicians or a workplace inspection **SUVA** – workplace inspections with detailed exposure assessment
Standardisation and quality control of collected data	Not specifically related to typology All systems implement different kinds of quality control measures and different levels of standardisation These measures may differ depending on scope of system (for instance possibility of more clearly defining reportable cases, work-relatedness criteria, variables and so on in systems monitoring specific group of diseases, such as pesticide related)	Standardisation of coding procedure; implementation of coding for exposures and for description of job tasks (not only occupation/industry) Quality control of reported data and coding during assessment/screening phase Implementation of standards to be fulfilled in order to transfer case reports to database to enable national and international comparability Provision of clear case definitions and protocols for exposure assessments	**RNV3P** – quality control of coded data by senior expert; alerting if data are missing or are not adequately coded; regular updates of coding, adding new exposures to thesaurus **MALPROF** – data quality is the starting point of work-relatedness evaluation **SENSOR** – clear definition of reportable cases, work-relatedness criteria; organisation of all collected data using standardised variables; organisation of coding exercise to improve quality of coding

Driver	Status of the driver depending on the types of systems	Measures to strengthen the driver	Good practice examples
		Flexibility of these standardisation norms (opportunity to discuss and adjust them)	**OHSP Navarra** – operative case definition for each disease; the interpretation can be discussed and adjusted in annual follow-up meetings
Improving data for policy	Non-compensation-based systems are mainly developed to improve data collection on WRDs (THOR, RNV3P, OHSP Navarra and so on) Some public health systems, such as the LFS, have also been implemented with the aim of providing statistical data on incidences and trends including those regarding WRDs and ODs	Development of sophisticated statistical methods, which take into account and adjust for the factors that might influence the 'true' incidences/trends (variation in number of reporting parties, reporter fatigue and so on) Triangulation of data sources can improve data for policy; different systems are suitable for different purposes (for example combining data from a more sensitive system with a low threshold for reporting with a more specific signal coming from a system with strict and standardised reporting and assessment procedures; these signals can then be integrated and used for different purposes)	**OHSP Navarra –** the aim of the system is to minimise under-reporting of ODs; the incidence of ODs in Navarre is six times higher than the average incidence throughout Spain **LFS** – provides the widest definition of work-related illness and workplace injuries; produces quarterly data on the overall number of workers and special modules, including information on the number of workers with occupational injuries or ill health; this enables 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 **THOR** – sophisticated statistical methods; triangulation of data with the LFS in order to provide complementary data
Awareness and detection of new/emerging WRDs	In general, non-compensation-based systems and sentinel systems are more likely to capture new/emerging WRDs Some of these systems are specifically designed to detect new WRDs and therefore have specific methods for these purposes Compensation-based systems such as SUVA are limited in detecting new/emerging WRDs	Raising awareness of new/emerging WRDs among reporting parties; implementation of web-based platform that enables learning about these new risks; distribution of case reports describing examples of identified WRDs; meetings/symposia with participation of reporting parties to disseminate information on new WRDs Designing a specific 'sub-scheme' for reporting suspected cases of new/emerging WRDs Work-relatedness evaluation of suspected cases of new/emerging WRDs performed by (a team of) experts	**THOR** – EELAB provides opportunity for reporting parties to learn about new/emerging WRDs; case reports on new WRDs distributed to all reporting parties though quarterly reports; THOR-EXTRA – additional scheme designed specifically for identification of new/emerging WRDs **SIGNAAL** – specifically designed to capture new WRDs; possible to report symptoms only, without clearly defining diagnosis; evaluation of work-relatedness by team of experts **MALPROF** – identification of new correlation between existing WRDs and specific jobs/industries; usage of specific statistical methods –proportional reporting ratio

Driver	Status of the driver depending on the types of systems	Measures to strengthen the driver	Good practice examples
	because of strict regulations about high probability of work causality	Implementation of statistical methods to identify potential new WRDs and new correlation between existing WRDs and specific industries Implementation of a 'sub-system' within existing compensation-based system to allow reporting of potential identified new/emerging WRDs that are not compensated for; these data could be considered in revision procedures of official list of ODs Awareness of new WRDs is higher in certain sectors (for example health sector); in addition, the presence of homogeneous exposure among a group of workers helps in monitoring new WRDs	**RNV3P** – data mining and identification of disproportionality signals in existing database; proactive search for cases in response to alerts of new WRDs from other sources (literature, NIOSH, Modernet) **GAST** – initiated to provide an epidemiologic response to unusual health events at workplaces and to alert to new/emerging work-related health risks and diseases **HHE** – mainly used to investigate unusual health problems at work, well equipped to detect new/emerging WRDs
Link with prevention and communication with occupational/public health authorities and different stakeholders, including employers and workers	Communication with governing bodies is a facilitator for non-compensation-based systems, which mostly use data to provide OSH data and input to national preventive strategies and policies Support from public health authorities is a driver for systems with public health scope Mainly well established in sentinel systems and compensation-based systems	Usage of data for direct workplace interventions or to identify trends in WRDs or specific groups/sectors at risk and develop targeted preventive actions and policies by engaging different stakeholders Using a reported case to investigate a work situation, determine risk factors and give advice on prevention Strengthening two-way communication with OSH governing bodies; providing input for policy recommendations targeting specific industries, vulnerable groups and so on, taking into account age and gender data to better target prevention Establishing communication with a public health authority in order to warn about emerging risks that can result in adverse public health effects	**THOR** – usage of sophisticated statistical methods to produce data, which are then used to create work programmes targeting specific industries, age groups and so on **SENSOR-Pesticides** – usage of data to identify vulnerable groups (adolescent workers, pregnant workers and so on) **MALPROF** – data input for local stakeholders such as companies, unions and workers' safety representatives; engaging local prevention units in preventive strategies **GAST** – the formalisation of existing information channels and collaboration between the regional health agencies, InVS, DST and the regional bodies in charge of protecting workers' health at the workplace **SENSOR Pesticides –** communication with Environmental Protection Agency when evaluating pesticides placed on the market

Driver	Status of the driver depending on the types of systems	Measures to strengthen the driver	Good practice examples
		Establishing direct communication with industries and providing an input for industries to implement preventive activities; possible usage of existing local/regional OSH units	**RAS** – the reporting physician can recommend a case for NLI intervention, or NLI physicians can recommend an intervention independently of the reporting physicians' judgement
Alert function	Alerting part of RNV3P and sentinel systems enables timely preventive actions primarily aimed at companies, and to a lesser extent policy recommendations	Using several channels to give alerts about each identified case that requires timely preventive actions: feedback to physicians for caution, warning industry to protect other workers, engaging other (national) OSH bodies for further implementation of preventive actions	**RNV3P, SIGNAAL** –alert about each identified case that triggers workplace preventive actions involving different stakeholders
Independence from compensation	Independence of preventive actions with regard to compensation is driver in compensation-based systems	Raising awareness and implementing preventive measures in companies tackling new/emerging risks regardless of recognition of and compensation for possible related ODs; separate insurance and prevention funds	**SUVA** – implementation of preventive measures against burnout in companies
Financial support and resources	Mainly an issue in systems not related to compensation Compensation-based systems (SUVA) have somewhat stable financial support from insurance fundingBetter financial situation if the system is part of an official governmental programme	Constantly demonstrating significance of work performed by system Producing and publishing deliverables that will not only point out emerging problems in OSH but also evaluate potential solutions and offer new onesDeveloping smaller projects targeting specific OSH areas and looking for further funding from sources interested in these very specific areas	**THOR** – produces reports that evaluate preventive actions implemented by governing bodies **THOR** – developed *The Asthma Workplace Charter*, supported by Asthma UK in consultation with HSE **MALPROF** – adapts structure of system to existing information resources with adequate expertise **HHE** – financial support from the government ensures that access to the programme is easy; consequently, the study can commence as soon as possible, the parties need not selectively search for research agencies and the reports are not restricted to the company

4.2 Two types of sentinel signals generated

Two main types of sentinel signals seemed to emerge from the systems described and analysed in this project: individual sentinel signals and population-based sentinel signals. Figure 6 summarises the characteristics of the most suitable, 'ideal' sentinel approach as well as alternative approaches for capturing these individual and population-based sentinel signals as described below. To some extent, each of these approaches provides an input mainly for a certain group of stakeholders (workplace level, public health authority or OH authority). This link is represented through the use of the same colour in Figure 6.

4.2.1 Individual sentinel signals

On the one hand, 'real' sentinel systems (such as SIGNAAL or GAST) seem to be the most suitable approach to detecting both **individual cases of new WRDs and new exposure-WRD correlations.** From here on, this type of signal will be referred to as 'individual sentinel signals' in the report. Systems designed to detect individual sentinel signals mostly capture a smaller number of cases and can therefore afford a more sensitive approach and high expertise in terms of work-relatedness evaluation. Furthermore, the identification of these individual cases is more likely to lead to focused preventive interventions, which will target the workplaces in which the signal emerged. If the signal becomes strengthened and more specific (after an investigation or a larger number of identified cases), dissemination to an occupational or public health authority could take place. This would support the development and implementation of nationwide policies or policies targeting specific sectors, types of occupations or workplaces, or vulnerable groups of workers. However, for this to take place, communication channels between the alert and sentinel system and the national occupational/public health authority must be well established.

An alternative approach to a 'real' alert and sentinel system could be to integrate an alert and sentinel aspect into a non-compensation-based system (such as RNV3P or THOR-EXTRA), a compensation-based system (such as SUVA) or a public health system (such as PISP). These systems are primarily designed for other purposes (compensation, statistics or public health surveillance), but have specific features suitable for an alert and sentinel function integrated into the system by allowing the usage of the existing infrastructure and expertise to, for example, capture individual sentinel signals. These alternative approaches are built upon a team of OH experts who can assess individual cases of potential new WRDs and can use the reported data to produce signals. A strong point of these systems is the established support by an occupational/public health authority (such as ANSES for RNV3P, HSE for THOR and EPA for PISP). PISP is a somewhat unique approach because it was derived from SENSOR-Pesticides, which is a sentinel system, and therefore it has elements of both a public health system and a sentinel system. This enables, on the one hand, individual signals of high quality to be captured through an alert and sentinel approach and, on the other, preventive actions and policies in the domain of public health to be implemented (for example evaluation of chemicals placed on the market).

4.2.2 Population-based sentinel signals

The second type of signals is those that allow the identification of new exposure-WRD links, but rely on a more comprehensive approach by aiming at the **identification of groups of workers or economic sectors at risk**. From here on, this type of signals will be referred to as 'population-based sentinel signals' in the text. Population-based sentinel signals can be captured by using several different approaches; some of them are described in this report but others (such as different types of epidemiological studies or OH surveillance (health screening of workers)) are outside the scope of this research.

Among the systems analysed and described in this report, the group of non-compensation-based systems seems to be the most suitable for capturing this type of signal. These systems have a wide scope and capture many cases, as their primary function is to produce nationwide statistics on

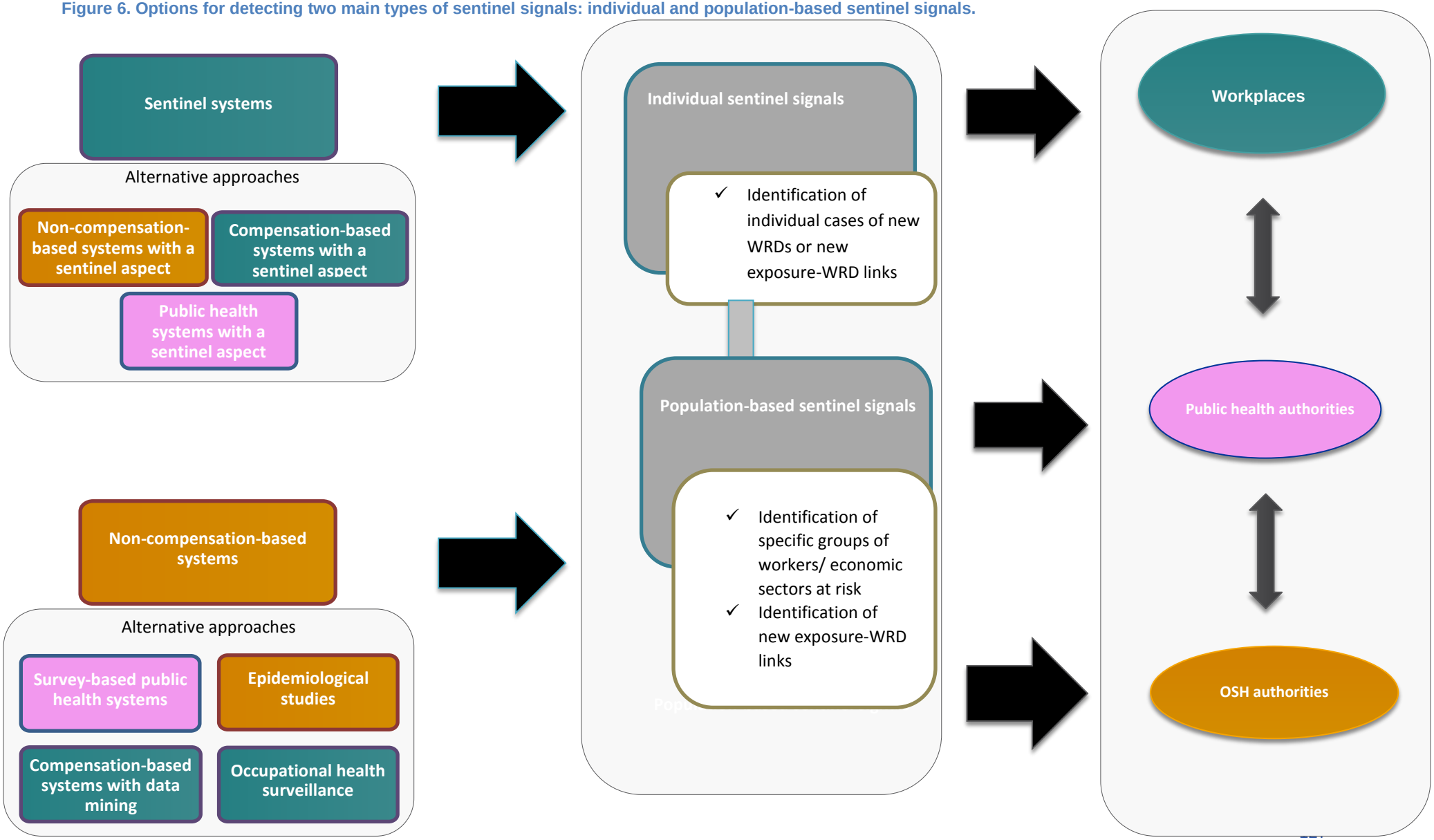
incidences and trends in OH. The main ways of identifying population-based sentinel signals are sophisticated statistical methods and data mining. Different databases can be used as a starting point for these analyses. A smaller number of systems use databases comprising cases reported individually to the system itself. These are non-compensation-based systems such as RNV3P, THOR and MALPROF, which were primarily designed for statistics, but have an integrated sentinel aspect involving detailed assessment of each reported case, which can also generate individual sentinel signals. All reported cases are stored in a database, which is then used to perform sophisticated statistical analysis (THOR) or data mining (RNV3P, MALPROF) to identify vulnerable groups of workers or economic sectors with an increased incidence of specific WRDs.

An alternative approach to generate population-based signals is to use external databases in order to search for signals. For instance, data mining can be performed in a database of compensation claims. This approach is the basis of the Washington SHARP system, described more in detail in the literature review report (EU-OSHA, 2017). In the case of MALPROF in Italy, data mining in the Italian database of compensation claims (INAIL) is also occasionally performed. At the May 2017 expert workshop, it was announced that a similar approach would be implemented in the French system EpiNano in the future. An example of data mining in non-compensation-related databases is seen in the Italian system OCCAM, which has used hospital records and data from cancer registries to identify correlations between economic sectors and increased prevalence of different types of cancer.

Finally, another alternative approach is a survey-based public health system with a wide scope (such as the LFS, described in section 3.4), which can generate input for public health authorities, resulting in preventive interventions.

A common feature of all these approaches is that they use already reported data as input for the national OH authority, which supports the development of policies targeted at specific economic sectors/industries.

Figure 6. Options for detecting two main types of sentinel signals: individual and population-based sentinel signals.



NB: Different types of approaches provide an input mainly for a certain group of stakeholders (workplace level, public health authority, OSH authority). This link is represented through the use of the same colour on this figure.

4.3 Recommendations for improvement of alert and sentinel surveillance in the EU

4.3.1 General recommendations

This section provides recommendations regarding the improvement of alert and sentinel surveillance in the EU based on an analysis of the data gathered throughout the project.

The recommendations formulated propose two alternatives for the implementation of such surveillance in EU countries in which there is none:

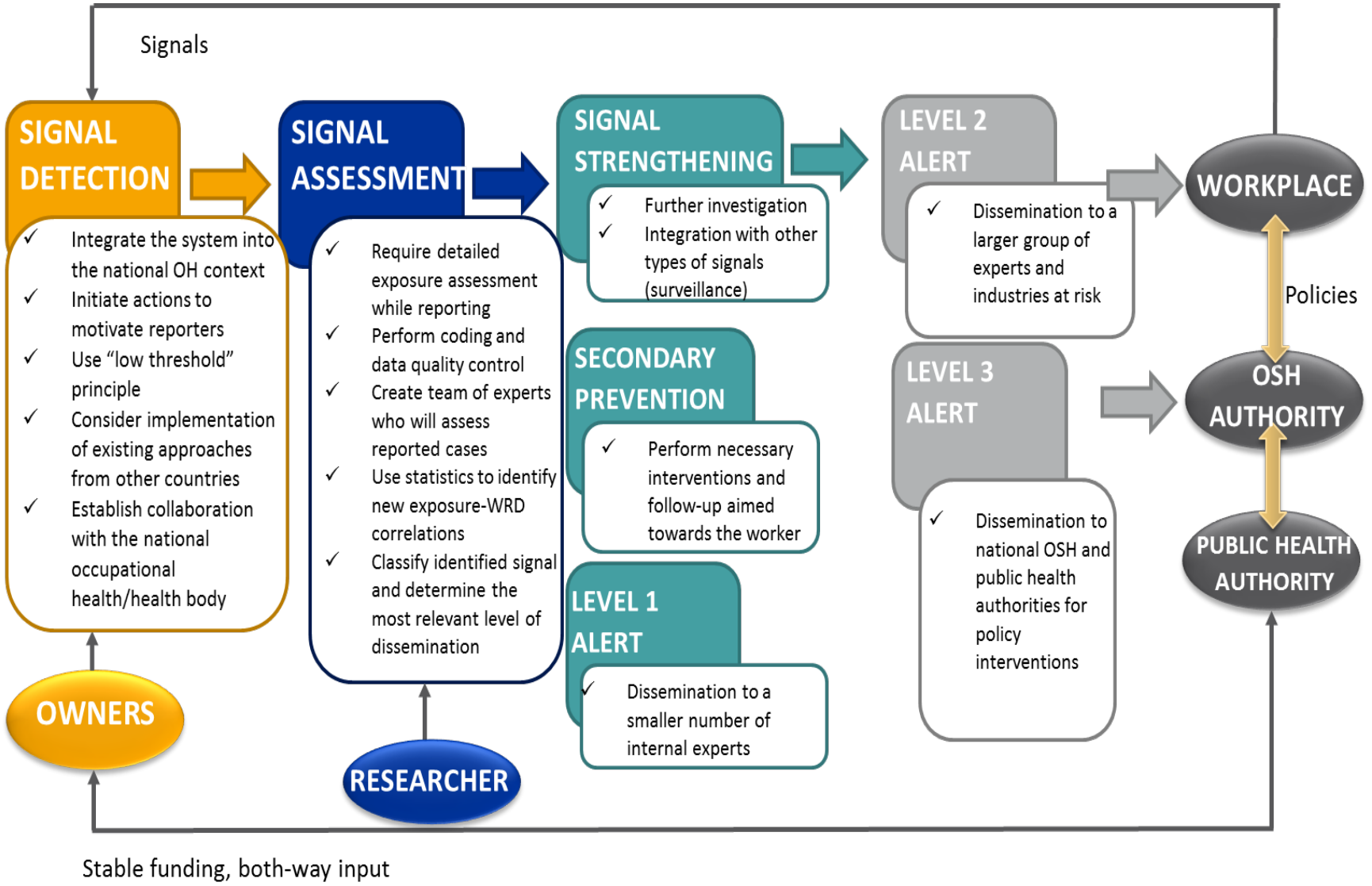
- developing from scratch an alert and sentinel system specifically designed to detect new/emerging WRDs, based on a 'model' system that consists of the main strong features identified in the examples of alert and sentinel approaches analysed in this project; or
- integrating an alert and sentinel aspect into an existing system primarily designed for other purposes – such as compensation, statistics or public health surveillance – following the example of the systems described in sections 3.1, 3.2 and 3.4 that are not 'purely' alert and sentinel.

In addition, these latter recommendations could also be useful to improve existing alert and sentinel approaches, in particular with regard to the quality of the different steps in the data flow, from identification and reporting of cases to the link with prevention and policies.

This section ends with a discussion on integrating alert and sentinel surveillance at the EU level, which could add a new perspective to OSH vigilance for new/emerging WRDs in the EU.

Figure 7 summarises the main steps in the generation of a sentinel signal as well as the key recommendations for the implementation of these steps discussed in this section and the main actors concerned.

Figure 7: Main steps in the generation of a sentinel signal, key recommendations and main actors



4.3.2 Setting up an alert and sentinel approach: recommendations for developers

- **Integration into national OSH context**

When planning an alert and sentinel system, **its position within the national OH context** should be clearly defined. The national OH context refers to the organisation of OHS, geographical coverage, type, number and function of OHS providers, and the accessibility of the OH specialists for different groups of workers, economic sectors and SMEs. The maturity of the current OH system is one of the main prerequisites for implementing an alert and sentinel approach. Therefore, when planning an alert and sentinel system the existing OH context should be analysed in order to determine the best approach to engage the existing OH organisations and experts available to recognise and report signals from their daily practice. The research team recommends implementing an alert and sentinel approach that builds upon and complements the systems already in place in the Member State. The majority of systems described in this report were indeed built on the existing network of OHS providers and experts. In some countries, additional initial steps might be needed before implementing an alert and sentinel system, for instance enhancing multisectoral collaboration or raising awareness of WRDs. Ideally, the structure of the system should be tested before implementing it in practice. This approach was followed when the Italian system MALPROF was developed (see section 3.2.3). A feasibility study was conducted before starting up the system, based on which the structure of the system developed was adapted to the existing information sources.

- **Reporters**

All experts involved in this project agreed that the **preferable reporting parties for an alert and sentinel system would be OH physicians**. These specialists can provide the highest level of data quality, as they have the necessary expertise in the field of WRDs and health and safety at work, and are certainly more likely to be aware of new/emerging OH risks than physicians who primarily work in other clinical fields. Therefore, an alert and sentinel system should ideally be built on a network of OH physicians. At the policy workshop, the participants acknowledged the importance of the strong network of clinics for ODs successfully implemented in the French RNV3P. Well-trained general practitioners can direct potential cases of new WRDs to occupational physicians in occupational clinics, who can then go on to report and initiate work-relatedness investigations. However, this is often difficult in practice, as the number of OH physicians is on the decrease and often not sufficient to provide a representative reporting source. Consequently, **GPs can be good supporting, complementary reporting parties**, as long as they are aware of new work-related health problems and are willing to collaborate with OH specialists in detecting and identifying cases of new WRDs. In this case, raising awareness of new/emerging WRDs and risks among GPs will therefore be crucial.

As discussed in section 4.1.2, having measures in place to ensure the **motivation of reporting physicians** is one of the main drivers of systems based on voluntary participation, which the majority of alert and sentinel systems are. The suggestions on how to increase the participation of reporting parties included simplifying the reporting procedure, delegating the reporting task to medical nurses and financial incentives for reporting. For example, systems should create and encourage two-way communication between the reporting parties and the experts who further assess the reported cases. In this way reporting parties would feel that the system provides them with something valuable in return for their effort and contribution.

An interesting aspect considered at the final workshop was **greater involvement of workers in reporting**. This approach is implemented in only a few systems identified in this project. For instance, the LFS in the United Kingdom relies on data reported by workers and is used as a complementary source of information to THOR based on the opinion of physicians. The workshop participants felt that the workers' perspective is not sufficiently represented in the existing systems and that this could be

considered as an alternative data source. This could be especially important for gaining a better insight into the incidence and prevalence of emerging multifactorial diseases such as musculoskeletal disorders. Moreover, greater involvement of workers' representatives, such as trade unions, was seen as another possibility to engage workers and acknowledge their perspective in identifying and preventing new and emerging health risks.

- **Case definition versus sensitivity of the system**

Whether or not case definitions should be part of the reporting procedure was a point of discussion among the stakeholders during the workshop. On the one hand, a clear case definition increases data quality already in the first phase of a sentinel signal identification. On the other hand, **a narrow case definition inevitably leads to a loss of sensitivity and a risk of missing cases of new WRDs**. Therefore, a clear case definition could allow more specific identification of new exposure-WRD links, but at the cost of reducing opportunities to identify new WRDs. Having various systems in place that can produce complementary signals, that is more specific versus more sensitive signals, allows them to be integrated and used for different purposes and is therefore a good option. Therefore, when developing an alert and sentinel system, it is important to look at the existing data sources in the country and ensure that the criteria for reporting and the case definition provide complementary signals. If another type of system for monitoring WRDs is in place, implementing an alert and sentinel system with a more sensitive approach is an important prerequisite for capturing new WRDs.

- **Integration of complementary signals at the national level**

Ideally, both the individual and the population-based types of sentinel signals should be **integrated at the national level by an occupational/public health authority**. This would enable the development of policies that would take into account different sources of information and different types of signals.

Examples that illustrate this approach have been implemented in France and the United Kingdom. The French national agency ANSES provides support to numerous systems in place in that country, such as RNV3P, EpiNano and GAST, described in detail in this report (section 3). One of ANSES's duties is risk assessment in the field of OSH, with the purpose of assisting the authorities with their health and safety policies. Furthermore, ANSES reports to the ministries of health, agriculture, the environment, labour and consumer affairs, thus ensuring that data gathered by all the reporting systems will have a holistic impact. Similarly, in the United Kingdom, the HSE triangulates data from different systems such as THOR and the LFS, described above, in order to build a comprehensive image of new/emerging work-related health risks, prioritise future actions and develop the most appropriate preventive policies.

In return, these authorities provide the reporting systems with sustainable support, input and funding. In addition, this support gives special credibility to the owners of the systems, which experts who participated in the expert workshop emphasised as being a crucial condition for setting up and maintaining a reliable, trusted and reputable system. Therefore, owners should aim to establish firm collaboration with national occupational and public health authorities.

- **Learning from success stories**

The stakeholders of the systems who were present in the workshop also emphasised the importance of sharing and learning from success stories and bad practices. By looking at the alert and sentinel systems successfully implemented in other countries, stakeholders who aim to develop an alert and sentinel approach in their own country can adapt and implement these already tested systems. Most of the owners of the systems described in this report saw their systems as potentially transferable to other countries, if the organisation of OHS is at least somewhat similar. For instance, experts from Italy have recently implemented a pilot network (Malattie e Rischi Emergenti sul Lavoro) (Curti et al., 2016; 2017), using the same approach as the RNV3P developed by their colleagues in France. The pilot network is completely built upon the RNV3P approach and includes a network of five OD consultation centres at

university hospitals. Patients are referred to these centres by their GPs, OH physicians or other specialists for the investigation of the putative work-related origin of the disease. Each centre collects data on cases through a structured and standardised data collection form, after which cases are evaluated for work-relatedness. Plans include expanding this network to other OH consultation centres across Italy.

As this report provides an in-depth description of several different approaches, we hope it will serve as a useful tool and an inspiration to follow the example of Italy and implement some of these approaches in other countries.

4.3.3 Assessment of the captured signal

Once a sentinel signal has been captured by a system, further steps in the data flow and assessment of the captured signal are crucial. Throughout these steps, the role of the researchers who assess reported cases, evaluate work-relatedness and alert other stakeholders is crucial. Therefore, collaboration between the owners of the systems and the researchers, in terms of establishing the criteria for assessing signals, is of great importance when setting up an alert and sentinel approach.

The issue of adequately assessing the captured signal has already been discussed in several places throughout this report. Nevertheless, it is one of the crucial prerequisites for establishing a causal relationship when assessing WRDs, especially in terms of identifying individual cases of potentially new WRDs (individual sentinel signals). Signal assessment is directly linked to the determination of the variables that need to be described when reporting a case, which obviously play a role in the quality of the work-relatedness evaluation. As already discussed in the section on drivers and obstacles, information regarding workplace exposure is crucial for identifying new WRDs or new exposure-WRD links. Therefore, **owners and researchers should request a clear description of the exposure from the reporting parties**, by including in the reporting form the minimum requested information necessary for establishing an exposure-WRD correlation (suspected exposure, duration of exposure, steps taken to quantify it, other possible exposures and so on). The reporting parties' awareness of and expertise in new/emerging risks and exposures is therefore important for a good-quality signal description allowing its proper assessment. However, signal assessment is an iterative process and therefore, the potential gaps in exposure information can be filled in during the work-relatedness evaluation step. This means that the experts who assess work-relatedness should be able to contact reporting parties to retrieve the missing information or even perform workplace inspections to assess exposure, if necessary. This is especially important in the case of signals coming from micro-enterprises and SMEs, where the exposure assessment tends to be less detailed or even missing, which means that potential new work-related health risks may not be detected and dealt with.

However, as discussed in previous sections, the requirement of a detailed assessment of each captured signal must be balanced with the risk of increasing reporting fatigue, which is one of the potential obstacles to maintaining alert and sentinel systems over time. Therefore, implementing a **detailed assessment of each case** is recommended in systems with a narrow scope and a small number of reported cases. This may be sustainable in 'real' alert and sentinel systems such as SIGNAAL or GAST, as they specifically aim to identify new/emerging WRDs. This may not be feasible in the case of systems that are primarily designed for other purposes (compensation or statistics) and capture a much larger number of cases; for these systems, the requirements for the assessment of the cases must be more carefully balanced. Therefore, adding to these latter systems an alternative data flow for the assessment of sentinel signals, rather than making the assessment of each case more detailed, may be a better alternative. This would enable two different types of data flow within the system: one for the primary objective of the system (for example compensation or statistics) and an alternative, alert and sentinel, type of data flow. This approach is illustrated in several non-compensation-based systems designed for statistics described in section 3.2, such as the French RNV3P system and the United Kingdom's THOR-EXTRA scheme, which is a subset of data for potential new WRDs only. An alert and sentinel aspect

can also be added to a compensation-based system, as was demonstrated in the example of the Swiss SUVA system. When introducing this aspect, stakeholders can use the existing work-relatedness assessment procedure, which is normally structured and strictly regulated in systems designed for compensation. The additional alternative data flow for the assessment of sentinel signals will still include the necessary investigation of work-relatedness, but will not be conditional on a positive decision regarding compensation.

The signal assessment should be followed by a corresponding alert response, aimed directly at the workplace level or OH authorities. Importantly, the addition of a sentinel aspect to an existing compensation-based/non-compensation-based/public health system should also undoubtedly be followed by the dissemination of information to reporting parties to raise their awareness of the possibility of reporting potential new/emerging WRDs in these systems.

The assessment of captured signals in alert and sentinel systems **should be clearly structured**. It should include a clear definition of the exposure variables that should be reported as well as the coding procedure. Among the described systems are several examples of how this can be implemented in practice. The most comprehensive approach can probably be seen in the French RNV3P system, with its specific thesaurus, which provides hierarchical codes for all types of exposures and explains how to use them. Whereas the structuration of exposure data can already take place in the initial phase of reporting, the implementation of the coding procedure can occur only in the later phase of case assessment and be applied by researchers who are well trained to perform this type of data cleaning.

At the 2017 expert workshop, the experts concluded that the nature and characteristics of certain groups of exposures and diseases affect the level of difficulty in assessing them. For instance, acute diseases and diseases related to exposure to chemical substances allow a more objective assessment of exposure and, consequently, of work-relatedness. On the other hand, in cases of musculoskeletal and psychosocial ill health, exposure assessment was considered more difficult. The participants considered the **establishment of clear assessment criteria particularly important** and a possible step forward, especially in the case of work-related mental health problems, which are on the increase. Therefore, establishing additional, clearly defined assessment criteria for certain groups of exposures might promote the capture of sentinel signals of work-related health risks and diseases that are more difficult to determine, such as multifactorial ones.

Whereas the exposure assessment of each individual case is a prerequisite for identifying new WRDs in systems based on individual sentinel signals, this might not necessarily be the case for population-based sentinel signals. As this type of signal aims to identify groups of workers or economic sectors at risk of a particular WRD, **the exposure assessment can take place after a link between an economic sector and increased incidence of a certain WRD has been identified**. The present report describes several examples from the group of non-compensation-based system: the Italian MALPROF, the French RNV3P (both aimed at all types of WRDs), THOR schemes for respiratory and skin diseases (SWORD and EPIDERM) or the Italian OCCAM, which particularly focuses on work-related cancer. In addition, survey-based public health systems with a wide scope (such as the survey-based LFS in the United Kingdom and Ireland) can alternatively be used for identifying population-based signals. These systems use sophisticated statistical methods to identify economic sectors/groups of workers at risk, after which different methods can be used to further investigate the possible exposures that have a causal link to an increased incidence of WRDs in a certain group of workers.

4.3.4 Signal strengthening and alert function

After the description and assessment of the signal, regardless of whether it comes from an individual case or from a population, it is necessary to strengthen the signal and determine the level of alert it will induce. To a certain extent, these are two parallel processes.

- **Individual sentinel signals**

In the case of individual sentinel signals, signal strengthening refers to the **work-relatedness evaluation performed by (a group of) experts**. The assessors are usually a multidisciplinary group of experts in new work-related health risks and diseases. A work-relatedness assessment includes a search for similar cases in the literature and/or in other systems, and discussion among the experts to make the final decision based on the evidence provided.

Although the evidence in the literature on similar cases may often be scarce, other cases may have been captured by other systems but not described in the published literature. Cooperation between experts from different systems and countries is therefore essential. Facilitating such cooperations is the objective of initiatives such as Modernet – a network of experts on new/emerging work-related health risks and diseases that enables them to discuss cases reported to sentinel systems in different European countries – and OccWatch, an online platform – initiated by the Modernet actors and hosted by ANSES in France to support international cooperation also beyond the Modernet network – where experts from different countries can report and discuss cases of new WRDs.

The strengthening of an individual sentinel signals should take place in parallel to **secondary prevention,** that is prompt and appropriate medical as well as workplace interventions towards individual workers whose cases have been reported, in order to stop or slow down the progress of the disease. At the workplace, the prevention measures implemented should follow the hierarchy of control measures to eliminate or minimise the exposure at source, for instance through substitution or different types of technical measures (enclosures, adequate ventilation systems and so on) and organisational measures (such as job rotation, aimed at reducing exposure duration and intensity; or more radical measures such as temporary or permanent reassignment of the worker). **Secondary prevention should be implemented regardless of the signal strength and as soon as the initial assessment of the signal is made.**

Depending on the characteristics and strength of the captured signal, **various levels of alert can be triggered**. The alert level is determined during the work-relatedness evaluation process. The three different levels of alert presented in Figure 6 were mainly developed on the basis of the recommendations of experts and stakeholders that emerged during the workshop, and are closely linked to the approach developed by the French RNV3P system. The overall idea of this approach is that a weak signal leads to the lowest level of alert, whereas higher levels of alert are triggered by a stronger signal. The criteria for determining the level of alert in the French RNV3P system are the level of severity of observed health effects in the reported case and the level of imputability (attributability of health effects to the identified exposure in the views of the worker and the OH expert). After both of these components are given a score of 0-4, the final score of each individual case is calculated. A summary of all the identified individual cases provides the final emergence score, which determines the appropriate level of action. A similar approach is implemented in SIGNAAL, the sentinel systems implemented in Belgium and the Netherlands, where the signal is given a score of 1-4, which indicates the level of priority of further actions. The score is calculated as a summary of the following individual scores: the estimation of seriousness of the health complaints, the frequency of exposure in the relevant profession, the intensity of exposure in the relevant group of workers, the likelihood that the exposure could occur in other workers and the size of the population at risk from this specific exposure. Some other systems use a more simplified approach, asking the experts who assess work-relatedness to classify the exposure-WRD link into different categories (for instance ‘definite’, ‘probable’, ‘possible’, ‘suspicious’, ‘unlikely’, as used in SENSOR-Pesticides), which affects the alert actions. To summarise, **categorisation of the signal, which will determine the appropriate level of alert, is recommended**. This categorisation should be based on the work-relatedness evaluation and should rely on the estimation of strength of the exposure-disease link, the seriousness of health complaints, and the estimated population of workers at risk (based, for instance, on the number of reported cases or the estimation of exposure frequency in the relevant profession).

Level 1 is the lowest level of alert and refers to the dissemination of warnings to an internal group of experts, mainly including OH physicians, GPs or other medical specialists who are reporting parties to the system and are part of its established network of experts. The main objective of this level of alert is to raise awareness of the newly identified exposure-WRD link and to sensitise the reporting parties so that they are more likely to identify potentially similar cases in their clinical practice and report

them to the system. This is a very important process, which leads to increased awareness of new WRDs among reporting parties and makes the whole approach an ongoing learning system. This internal alert can be raised through various means of communication. For instance, if reports are regularly produced and distributed to the reporting parties, these cases of new WRDs can be added to them and distributed together with the rest of the regular data derived from the system. Furthermore, as most of the systems work through a web-based platform, descriptions of the captured cases can be integrated into the online platform. This should be done in such a way that they are visible to the reporting parties who access the platform to report cases, or distributed individually to each reporting party, depending on technical feasibility and how many reporting parties there are.

Level 2 involves wider dissemination of warning signals – possibly to a larger group of experts and/or to workplace-level actors. In the French RNV3P system, this involves searching for similar cases outside the network (that is reported in other countries) or interaction with some partners of the system. As this level of alert is mainly raised when a cluster of cases is identified or severe health effects are involved (according to the proposed algorithm to categorise the level of alert, as discussed above), it generally involves direct dissemination to workplaces. By providing workplaces with information on the identified risks, it encourages them to request further input from OH bodies on how to better protect their workers from the identified health risks. During our expert workshop, occupational health experts involved in alert and sentinel systems pointed out the importance of collaboration with employers and workers' representatives in the implementation of workplace preventive actions. However, they emphasised that employers might hesitate to provide data to alert and sentinel systems voluntarily and on their own initiative because of a potential conflict of interest as well as the fear of media hype if the media get hold of the information. Therefore, it is necessary to create reporting channels that allow employers and workers' representatives to safely report new risks and WRDs to alert and sentinel systems, and in return provide them with assistance to implement preventive actions at the workplace. Finally, in addition to direct communication with the workplace and benefits in terms of workplace prevention, this level of alert can include the initiation of epidemiological studies seeking to further examine the exposure-WRD link or the extent and severity of the associated health risks.

Level 3 is the highest level of alert and targets occupational and public health authorities. This level of alert should be initiated once there is strong evidence of an exposure-WRD link, including serious health effects or a large population at risk. At this stage, close collaboration with different OSH and/or public health authorities is crucial. Depending on the scope of the estimated exposure, it might be more appropriate to engage the OH authorities, who will then target workplaces at risk and request measures such as further investigation of the critical exposure and health risks in question, control measures to eliminate or reduce the exposure, or medical surveillance of workers exposed. If the general population is also at potential risk, public health actions might be necessary. An example described previously is the SENSOR-Pesticides system, in which cases of new WRDs related to exposure to pesticides can lead directly to the re-evaluation of chemicals on the market by the Environmental Protection Agency.

- **Population-based sentinel signals**

In the case of population-based sentinel signals, signal strengthening as defined in the section on individual sentinel signals is not necessarily performed. Since population-based signals include identification of vulnerable groups of workers or an economic sector with an increased incidence of a WRD, a work-relatedness investigation is not carried out after the identification of the signals. Therefore, systems that use this approach rely on the work-relatedness evaluation performed when cases were reported to the database as a starting point for signal detection. The level of detail of the work-relatedness evaluation depends on the database (for example more strict evaluation in databases of compensation claims versus less strict evaluation in non-compensation-based systems that rely on the opinion of the reporting physician). In some approaches, the starting point includes non-occupational health data, such as hospital records or national disease registries. In this case, no work-relatedness evaluation is performed prior to signal identification. Instead, these systems use data mining to link the recorded diseases with data on economic sectors/workplaces/exposures and thus draw conclusions on the causal link between these two variables, which may be previously unknown. This approach is implemented in the Italian OCCAM system, for instance, in which data mining is performed in cancer registries and hospital discharge records. Alternatively, further investigation into the causal link with work

can take place in the form of additional epidemiological studies or the engagement of groups of experts who assess the identified cases, depending on the scope of the identified signals.

In terms of alerts and links with prevention, these approaches have little connection to secondary prevention or Level 1 alerts (which are linked more to the identification of individual cases) and are more suited to producing **Level 2** or **Level 3** alerts (alerts aimed at workplace-level actors and occupational/public health authorities).

Regarding the **Level 2 alert**, which is aimed at workplace-level actors, several examples described in this report illustrate established communication with the workplace, resulting in two-way, top-down and bottom-up, data input. For instance, the Italian MALPROF system and the United Kingdom's THOR system use their databases to **investigate emerging work-related health risks in specific sectors and types of workplaces and to determine preventive actions**. These priorities can be set methodologically, by looking at the warning signals that emerge from the data analysis. Investigations can also be triggered by another warning signal coming from an authority or from another surveillance systems, with the objective of strengthening the signal before appropriate actions are initiated. For instance, a MALPROF expert received an input from the Italian compensation-based system after a trend of increasing compensation claims was identified in the construction industry. After this, the MALPROF researchers carried out statistical analyses, which resulted in the discovery that spine diseases are the most frequently reported diseases among workers in this sector and that they are at an increased risk of knee injuries. These conclusions led to preventive actions targeted at this specific sector. A similar example is the United Kingdom's THOR system, which receives requests from the HSE regarding a specific risk to be further investigated.

Vice versa, a request for an investigation into potential emerging risks among specific groups of workers can also be made by employers or workers' representatives directly. **Communication between the system's actors should be established in such a way that the employers and workers' representatives can ask the systems to gather some specific data**, after adequate data protection is ensured by the researchers of the system who produce the data. Providing data derived from alert and sentinel systems as a response to this type of requests has the double advantage of raising companies' and workers' awareness of an emerging risk and providing a better insight into the potential preventive measures that need to be taken.

Furthermore, population-based signals can generate Level 3 alerts to OH and public health authorities and therefore be used to **support long-term policies and prevention plans, by identifying emerging trends in WRDs**. Several examples have been described in the present report. One of them is the well-established collaboration between the United Kingdom's THOR system and the HSE, which results in the HSE receiving input on emerging incidences and trends in WRDs derived from data collected by THOR. This input is then used by the HSE to develop preventive campaigns and interventions. Moreover, THOR provides input for the United Kingdom Parliament to develop long-term preventive policies, by tackling WRDs with increased incidence, as shown by the THOR data. Therefore, establishing collaboration with OH and public health authorities is essential in order to use the identified population-based signals for the development of preventive strategies and policies.

To conclude, population-based signals can be a valuable source of information in terms of identifying emerging work-related health risks in specific sectors/types of workplaces/groups of workers, and identifying trends in WRDs. Systems that produce such signals should have two-way communication with OH authorities and workplaces. On the one hand, OH authorities or workplace-level actors (employers and workers' representatives) should provide direct input into the systems about economic sectors/workplaces, hazards or WRDs that need to be further investigated. On the other hand, the systems should produce alert signals aimed at OH authorities and workplaces in order to strengthen the signals and provide support for the prioritisation and long-term planning of preventive policies and actions.

4.3.5 Visions for the future: towards EU-wide alert and sentinel surveillance

The figures for WRDs across EU Member States are currently not comparable, and adequate institutional and other mechanisms to respond to early warning signals are lacking (European Environment Agency, 2013). Therefore, one of the main points arising from the expert workshop was the need to harmonise data on new/emerging WRDs at the EU level. Although currently not on the political agenda, the development of an EU-wide alert and sentinel surveillance system would clearly improve the harmonisation of data on new/emerging WRDs and aid the implementation of suitable policies and preventive measures once signals are identified. Alternatively and more realistically, **better cooperation and exchange of data and information between alert and sentinel-like systems from Member States** is a way forward to improve alert and sentinel surveillance at the EU level. The experts agreed that there is an urgent need to further develop international networks of experts such as Modernet and initiatives such as the international OccWatch platform in order to establish a strong network of data exchange and cooperation across the EU. At Member State level, the existing alert and sentinel systems should be strengthened and, in the Member States where there is no such system, an alert and sentinel-like function could be integrated into other types of monitoring systems already in place, following the example of some systems described in this report (sections 3.1, 3.2 and 3.4).

- **Sentinel signal pathway: from national to EU level**

Considering the different steps in the data flow of alert and sentinel systems – signal detection, signal assessment, signal strengthening and alert (see Figure 6) – it is of particular importance to have better signal strengthening and alert mechanisms at the EU level in order to improve alert and sentinel surveillance in the EU. However, signal detection and assessment should undoubtedly be performed at the national level, as these steps require the engagement of a large number of different groups of actors (reporting parties, assessors) from different bodies. In addition, the specific tasks and roles of these actors in signal detection and assessment are determined by the specificities of the national OSH context. Therefore, at this point, it is idealistic to try to make the data collection step in the alert and sentinel approaches completely uniform across Member States. Instead, EU bodies could **encourage the development of alert and sentinel approaches in the Member States and support EU-level information exchange on signals captured, signal strengthening and alert raising.**

Setting the identification of new/emerging WRDs as a long-standing priority at the EU level was underlined as a driver of the implementation of alert and sentinel approaches at the national level. EU bodies could also promote guidance on how to implement different types of alert and sentinel approaches, depending on the national OH contexts in place in different countries. Guidance documents could be developed on the basis of examples of successful alert and sentinel approaches already in place in various Member States, some of which are described in section 3 of this report. Finally, EU-level support to raise awareness among different groups of stakeholders of the new/emerging work-related health risks and diseases and of the contribution of alert and sentinel approaches to their identification would also help to make the case for the development of such systems at the national level.

At the policy workshop, the participants showed particular interest in the OccWatch platform. In the testing phase at the time of writing of this report, OccWatch provides an international online platform (initiated by the Modernet members and hosted by the French ANSES) through which cases can be reported and experts from different countries can comment on these cases. The objective is to support international collaboration and the sharing of data and knowledge on new/emerging work-related health risks and diseases. Furthermore, OccWatch is intended to present a second line of reporting. Ideally, **cases would first be 'filtered' though a national alert and sentinel approach** and, at this point, national experts should determine whether or not the case requires an international input. Therefore, the implementation of a national alert and sentinel approach would be a desirable step before joining the OccWatch platform. A good example is SIGNAAL, which is compatible in design with OccWatch. SIGNAAL could be a good model to implement in countries that have no alert and sentinel approach in place.

- **Harmonisation of data across the EU**

In addition, in terms of signal assessment, **better EU-level harmonisation of the data recorded** at the national level would be useful. For instance, the development and implementation of a uniform thesaurus to create hierarchical codes for different types of variables, especially concerning exposure data, could improve information exchange and collaboration in the identification of new WRDs across Member States. In systems that establish case definitions, these definitions could be harmonised at the EU level, especially in disease-specific systems (such as those designed to capture WRDs related to nanomaterials). Another step in the signal assessment that could be more strictly structured and harmonised is the work-relatedness evaluation procedure. In fact, the systems described in this report that have a structured approach towards work-relatedness evaluation (such as the French RNV3P or SIGNAAL in Belgium and the Netherlands) use a very similar approach to the work-relatedness evaluation. Therefore, these examples could be used as a basis to develop an **EU model for the work-relatedness evaluation** of potential new WRDs for alert and sentinel systems in EU countries.

- **Signal strengthening through an international network**

The establishment of an EU sentinel surveillance network is essential from the aspect of signal strengthening. More specifically, **forming a group of international experts on new/emerging WRDs**, who can help assess cases reported at the national level, is recommended, following the example of the Modernet network and OccWatch platform. Therefore, these two networks can be used as a starting point, and could be further supported and internationalised. Cases of new WRDs reported at the national level could be stored in an EU online database (with an adequate balance between data confidentiality and accessibility). This database could be used for data mining, statistical analysis and literature searches for similar cases as part of the work-relatedness evaluation of new cases. This could be of particular significance when cases of potentially new WRDs with a small incidence are reported. Indeed, when no similar cases are described in the literature, similar cases reported in another country could aid the assessment procedure and the establishment of work-relatedness. Pooling knowledge on new WRDs could also help make the case for EU-level initiatives to further investigate specific exposures or WRDs, or implement other, complementary, types of surveillance.

- **More efficient alerts and prevention of new WRDs**

Finally, **better coordination of the systems' alert function** at the EU level would contribute to better identification and prevention of WRDs in the EU. The time lag between when cases are captured and alerts are raised is often too long, which hinders timely prevention. Therefore, guidance for systematic, harmonised determination throughout the EU of the appropriate level of alert based on the data reported would be helpful. Furthermore, whereas secondary prevention and Level 1 alerts (to internal group of experts) are to be implemented at the national level, Level 2 and Level 3 alerts could be raised by both national and EU OSH and public health bodies. For instance, national-level actors could play a more significant role in triggering actions at the workplace-level, such as by requesting further investigation of the identified exposure-WRD link, increased medical surveillance of workers and/or the implementation of (additional) protective measures to reduce exposure at the workplace. In addition, they could help strengthen the identified signals through, for instance, epidemiological studies to investigate the link between workplace exposures and health effects. On the other hand, EU actors could play a more significant role by disseminating alerts more widely. This could include alerts to OH experts though an international network, the development of recommendations and measures for the prevention of the WRDs identified, and appropriate communication of these. Communication with public health bodies should be established for a holistic preventive approach if relevant. Dissemination to national-level occupational and public health actors should also be established for the implementation of the recommendations and measures at the national level.

Last but not least, EU actors could support the **development of long-term policy plans**, based on integrated data recorded by different alert and sentinel systems across the EU. This could include the development of additional surveillance systems aimed at specific work-related exposures and specific WRDs (such as systems monitoring health effects of work-related exposure to nanomaterials) or specific groups of workers (systems for the identification of population-based signals among specific groups such as young workers, female workers or others). The output of these systems could support the development of evidence-based EU strategies and policies for the prevention of WRDs.

5 Conclusions

This report shows the following.

- There is no ideal surveillance system for new/emerging WRDs. **Different types of alert and sentinel approaches have their strong points and disadvantages** as described in this report. When implementing alert and sentinel approaches, stakeholders should take into account the national OSH context and the systems in place, and learn from good practice examples from other countries. In addition, they should aim to implement complementary approaches to those already in place.
- Some systems described in the report can generate **'individual sentinel signals'**, that is individual cases of potentially new WRDs or new exposure-WRD correlations. However, only a few systems are specifically designed to provide such signals. Real **sentinel systems**, such as SIGNAAL, GAST and HHE, are the only systems whose primary purpose is to identify individual cases of potentially new WRDs or new exposure-WRD correlations, and that therefore provide individual sentinel signals. These systems follow the sentinel model and assess signals though several steps: the reporting of cases by OH physicians or other experts, work-relatedness evaluations by a team of experts, the strengthening of signals through further investigation and the raising of various levels of alerts to trigger preventive actions.
- Alternative approaches to capturing individual sentinel signals are **compensation-based systems with a sentinel aspect**, that is an 'open list' approach or a set of data independent from compensation, an example of which is the SUVA system described above; **non-compensation-related systems primarily designed for data collection and producing statistics, integrating a sentinel feature**, such as the French RNV3P; and **public health systems with a sentinel aspect**, such as systems that monitor the health of the general population and workers and have features of a sentinel system, for example PISP in California (derived from SENSOR-Pesticides).
- Individual sentinel signals are mainly used to **raise alerts and trigger preventive actions at the workplace level**. However, if the signal is strengthened, they can **also be used to alert occupational and public health authorities**.
- Apart from individual sentinel signals, some systems can provide **'population-based sentinel signals'**, meaning that they can identify groups of workers at risk or economic sectors with increased incidence of a WRD. Systems that are suitable for identifying these signals are **non-compensation-related systems characterised by wide coverage and a large database that can be used for statistics and data mining**. Several good examples have been described in the report, such as THOR, OCCAM and RNV3P.
- Alternative approaches to identifying population-based signals are **data mining in the databases of compensation-based systems** (such as SHARP in Washington State) and **survey-based public health systems** (such as the LFSs in the United Kingdom and Ireland, described in the report). Additional sources of this kind of signal are OH surveillance and epidemiological studies, which are not within the scope of this report and were therefore not studied here.

- Population-based signals are mainly used as inputs for occupational or public health authorities, to **support long-term policies and prevention plans** by identifying vulnerable groups of workers and emerging trends in WRDs. However, population-based signals can also be used to strengthen individual signals (for instance different types of epidemiological studies to further investigate an exposure-WRD link).
- Some of the main **common drivers** of most of the systems are visibility of the system, motivation of the reporting parties to report cases, systematic and detailed exposure assessment, standardisation and quality control of collected data, awareness and detection of new/emerging WRDs, communication with authorities to initiate prevention, and political and financial support and resources.
- The **main gap in terms of monitoring specific groups of WRDs is the identification of multifactorial and/or long-latency WRDs**, such as mental diseases, musculoskeletal diseases or certain cancers. Improving the reporting of data on exposure assessment and the establishment of clearly defined assessment criteria for the evaluation of work-relatedness would help. With regard to economic sectors, the focus is still on traditional sectors such as agriculture and construction, whereas important sectors such as the hotel, restaurant and catering sector, or 'newer' growing sectors such as communication and IT services are covered only poorly or not at all. There is also a lack of alert and sentinel systems that capture potential work-related health disorders related to new and emerging technologies such as those involving nanomaterials or robotics.
- **Two-way communication** between stakeholders and owners/researchers of the systems is essential for long-term maintenance of alert and sentinel systems and their effective link with prevention. Key stakeholders in terms of prevention are workplace-level actors (including employers and workers' representatives), OH organisations and services (such as labour inspectorates) and occupational (and, if relevant, also public) health authorities. On the one hand, these stakeholders should provide the systems' owners and researchers with input about the economic sectors, hazards or WRDs that need to be further investigated. On the other hand, the systems should produce alerts targeting occupational (and, if relevant, public) health authorities and workplace-level actors, as relevant, in order to support evidence-based prevention and policy-making.
- Although currently not on the political agenda, the development of an **EU-wide alert and sentinel surveillance system** would contribute to the harmonisation of data on new/emerging WRDs, to the better identification of WRDs – thus complementing official OD figures and giving a more realistic picture of the burden of WRDs in the EU – and to the development of evidence-based prevention and policy. Alternatively and more realistically, better exchange of data and cooperation between alert and sentinel approaches from Member States is a way forward to improve alert and sentinel surveillance at the EU level. At Member State level, the existing alert and sentinel systems should be strengthened – in particular, collaboration between the national OH authorities and the actors of alert and sentinel systems is essential for the sustainability of the systems and their effective link with prevention – and, in the Member States where there is no such system, an alert and sentinel-like function could be integrated into other types of monitoring systems already in place, following the example of some systems described in this report. Further necessary steps are the harmonisation of the data reported by these systems and the establishment of an international network for exchanging data and knowledge about new WRDs.
- The importance of **international collaboration** between different countries and systems was highlighted recurrently throughout this project. International initiatives such as the Modernet network and the OccWatch platform are good starting points and, in the course of this project, various experts expressed their interest in taking part in OccWatch.

This project has generated insights into various alert and sentinel approaches for the detection and prevention of work-related diseases and has encouraged the exchange of information and good

practices. The workshops held as part of the project contributed to the exchange of experiences and the sharing of success stories, which helps actors in countries where there is no alert and sentinel systems to make the case for such approaches. Thus, we hope this report will serve as a useful tool and an inspiration to implement some of these approaches in other countries. The workshops also fostered cooperation in the EU and gave rise to concrete opportunities for collaboration between participants, for example on a thesaurus for the coding of exposure data and through the OccWatch platform. As a follow-up to this project, EU-OSHA will continue to support networking and the dissemination of information on alert and sentinel approaches and new WRDs, on its website as well as through a series of national-level dissemination workshops.

6 Appendix A – 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
1A	Reporting of suspected ODs during mandatory worker medical examinations	RU	Rospotrebnadzor or 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 PH IH WO	OB	–	Worker's gender, age, occupational title and sector, address, workplace address, exposure, diagnosis	Y	EXPC	EXP LIT	S	Y Reports	Y	N	1989	–
1A	The UK Industrial Injuries	UK	The Industrial Injuries	WC	Y	PL	All, no SE	Y	P	WO	VOL	–	Demographic and administrative information,	N	EXPC	LIT	–	Y	–	–	1991	N

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	Disablement Benefit Scheme (IIDB)		Advisory Council (IIAC)										diagnosis, employer, occupation, information on GP, medical treatment, previous claims					Papers/symposia/website				
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	VOL	–	–	–	–	–	–	–	–	–	–	–
1A	Czech Registry of Occupational Disease	CZ	Státní Zdravotní ústav (National Institute of Public Health)	ST PRRS	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	–
1B	Erhvervssygdoms-registret	DK	Labour inspectorate — Working Environment Authority, National Board	–	Y	–	–	Y, OS	P	PH, DEN, WO,	OB	–	–	–	EXPC	–	–	–	–	Y	–	–

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			of Industrial Injuries							TUD EMP												
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
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	Y	EXPC	EXP, LIT	Y	Y Reports, stakeholders	Y	Y	1996	–	

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													imputability, susceptibility									
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	VOL	–	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	–
1B	Régime Général (General Regime)	FR	National Fund for Insurance of Occupational Diseases for Employees in the Private Sector	WC, PR	Y	All	All, no SE, CS, FA	Y, OS	P	WO	–	–	Demographic characteristics of the patient, diagnosis, occupation, economic sector, exposure, duration of exposure	Y	EXP	–	–	Y	–	Y	2002	–
1B	DGUV Statistics	DE	German Statutory Accident	WC	Y	All	–	Y, OS	P	PH, WO, EMP	–	–	Demographic characteristics of the patient,	Y	EXPC	–	–	–	–	–	1975	–

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			Insurance (DGUV)										diagnosis, occupation, economic sector, exposure, duration of exposure, level of imputability									
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 Republic of Latvia	LV	The Centre of Occupational and Radiological Medicine of Pauls Stradins, Labour inspectorate	WC	Y	All	–	Y, OS	P	PH, IH, WO	–	–	–	–	EXPC	EXP	Y	Y Papers, symposia	Y	Y	–	–
1B	Workers' Compensation and Welfare	KOR	Korea Occupational Safety and Health Agency (KOSHA),	WC, DC	Y	All	All, no CS, FA, FI,	Y, OS	P	EMP	OB	–	–	–	EXP	EXP	–	–	–	–	1964	–

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
	Service (COMWEL)		Occupational Safety and Health Research Institute (OSHIRI)				FOI, DEF, PUB															
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	–
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, econom sector	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
1C	Work Injury and Diseases Database (NWISP)	CA	Association of Workers' Compensation Boards of Canada (AWCBC)	WC	Y	–	–	N	P	–	–	–	Gender, age, nature injury, part of the body, source of injur event, occupation, industry	–	–	–	–	–	–	Y	1982	–
1C	PRESS-WORD	T W	Department of Health (DOH)	DC, ST, PR, WC	Y	All	–	N	P	PH	VO L	–	–	–	EXPC	EXP	Y	Y Seminars, statistics	Y	–	1995	2007
1C	Safety & Health Assessment & Research for Prevention (SHARP) Dermatitis Program	W A	Washington State Department of Labor and Industries	PR, DC	Y	WRS D	All	N	P	DM-WC		C	Case information extracted from management systen claims	–	–	–	–	–	–	–	1994	–
1C	Safety & Health Assessment & Research for Prevention (SHARP) Asthma Program	W A	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	Y	–	–	–	–	Y	–	2000	–

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													exposures and medical history									
1C	Safety & Health Assessment & Research for Prevention (SHARP) Musculoskeletal Disorders Program	WA	Washington State Department of Labor and Industries	PR, DC	Y	WRMSD	All	N	P	DM-WC	–	C	Case information extracted from management system's claims	–	–	–	–	–	–	–	1991	1999
1C+	Network of Occupational Diseases and Injuries Service (NODIS)	TW	Nine tertiary referral medical centres- Centres for Occupational Disease and Injury Services (CODISs)	DC, ST, WC, PR	Y	All	All	N	P	OP	VOL	–	Worker's gender, age, industry and occupation, diagnosed disease(s), time of diagnosis, workplace exposure and hazards that caused the ailment	Y	EXP	EXP	–	Y Dissemination, preventive actions	Y	–	2007	–
2A	Occupational Physicians Reporting Activity (OPRA)	UK and IE	University of Manchester	DC, ST	Y	All	–	–	P	OP	VOL	M	Worker's gender, age, date of birth, occupational title and sector of	Y	EXPC	LIT, EXP	Y	Y	Y	Y	1996	–

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													professional activity, exposures, diagnosis, date of symptoms onset					Papers, symposia website				
2A	THOR-GP	UK	University of Manchester	DC, ST	Y	All	–	–	P	GP	VOL	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	–
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	–
2A	Registry of WRD (Register for Arbeidsrelaterte 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,	Y	EXP	LIT, EXP	Y	Y Symposia, reports, WI, preventive actions	Y	Y	1987	–

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													exposures, diagnosis									
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	–
2A	Surveillance programme of Work-Related Disease (MCP)	FR	French Institute for Public Health Surveillance (InVS)	DC, PR	Y	All	All, no CS, DEF	–	P	OP	VOL	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	–

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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	–
2A	Surveillance Project for Intensive Notification (Peilstation Intensief Melden (PIM))	NL	Netherlands Center for Occupational Diseases (NCOD)	DC, ST	Y	All	All	–	P	OP	VOL	–	Clinical diagnosis, age, gender, exposure (information on physical, chemical, biomechanical and psychosocial factors), occupation, economic sector and consequences for work ability	Y	REP	–	Y	Y Annual report	N	Y	2009	–
2A	Occupational Health Surveillance	ES	Instituto Navarro de Salud Laboral (INSL)	DC, ST, PR	Y	All	All	–	P	PH	VOL	W	Administrative information on the patient, diagnosis,	Y	EXP	EXP	Y	Y Newsletters, seminars,	Y	Y	1998	–

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	Program in Navarre												occupation, economic sector, do co-workers experience similar pathology, work absence					preventive actions				
2A	Washington State Behavioral Risk Factor Surveillance System (BRFSS) — Worker Health Module	WA	Washington State Department of Labor and Industries, Centers for Disease Control and Prevention (CDC)	DC, ST, RS	Y	All	All	–	P	WO	VOL	AN	Work Health Module is incorporated in Behavioural Risk Factor Surveillance System (BRFSS) implemented across USA and consists of three modules: core questions, optional modules, state-added question	–	N	–	–	–	–	–	2002	–
2A	Doctor's reporting of illness according	SW	Labour inspectorate — Swedish Working	DC	Y	–	–	–	P	PH	–	–	–	–	EXP	EXP, LIT	Y	–	Y	N	–	–

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	to AFS 2005:6, § 11		Environmental Authority																			
2A	Occupational Disease Surveillance and Reporting System (ODSRS)	CN	Institute of Occupational Health and Poisoning Control (IOHPC), Chinese Center for Disease Control and Prevention (CCDC)	DC	Y	–	All, no M W	–	P	PH	VO L	–	–	–	–	–	–	–	Y	–	2006	–
2A +	French National Occupational Diseases Surveillance and Prevention Network (RNV3P)	FR	The French Agency for Food, Environmental and Occupational Health & Safety (ANSES)	DC, NE R	Y	All	All	–	P	OP + DM	VO L	–	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	Y	EXPC	EXP, LIT	Y	Y Dissemina tion and preventio n on several levels	Y	Y	2001	–

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													exposures, principal disease and comorbid diseases, level of imputability									
2A+	THOR-EXTRA	UK	University of Manchester	NER	Y	All	–	–	P	PH	VOL	–	Age, sex of patient, diagnosis, symptoms onset, 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 Papers, symposia, website	Y	Y	1989	–
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,	Y	EXPC	EXP, LIT	Y	Y Papers, symposia, website	Y	Y	1993	–

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
													diagnosis, date of symptoms onset									
2B	Surveillance of Infectious Diseases At Work (SIDAW)	UK	University of Manchester	–	Y	WRID	–	–	P	INF	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 Papers, symposia, website	Y	Y		1996	–
2B	Occupational Surveillance of Otorhinolaryngological Disease (THOR-ENT)	UK	University of Manchester	–	Y	WROD	–	–	P	ORL	VOL	–	–	–	–	–	–	–	–	–		2005	2006
2B	Musculoskeletal Occupational Surveillance Scheme for rheumatologists (MOSS)	UK	University of Manchester	–	Y	WRMSD	–	–	P	RHE	VOL	M	–	–	–	–	–	–	–	–		1997	2009
2B	Occupational Surveillance Scheme for	UK	University of Manchester	–	Y	WRAD	–	–	P	AU	VOL	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
	Audiological physicians (OSSA)												symptoms onset, exposure, occupation, economic sector									
2B	Surveillance of Occupational Stress and Mental Illness (SOSMI)	UK	University of Manchester	–	Y	WRMD	–	–	P	PSY	VOL	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 Annual report	–	–	1989	–
2B	Surveillance of Work-related and Occupational Respiratory	SA	National Centre for Occupational Health, the South African	DC, ST, PR	Y	WRRD	NON-M,	–	P	PU, OP, OHN	VOL	M/Y	Disease, industry and job in which exposure occurred and putative causative	Y	REP	–	IN	Y Papers, newslette	–	–	1996	2006

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	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						agent; a more detailed form for each case of occupational asthma collected, further information including method of diagnosis and history of patient					rs, brochures				
2B	Surveillance of Australian workplace Based Respiratory Events (SABRE)	AUS	Workers' Compensation (Dust Diseases) Board of NSW and Monash University Melbourne Australia	DC, ST	Y	WRRD	–	–	P	PU, OP, GP	VOL	2 M/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)

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													industry, location of industry (postcode), presumed agent and diagnosis									
2B	Ontario Work-Related Asthma Surveillance System (OWRAS)	CA	–	DC, ST	Y	WRA, WRB, WRR, WRS C	All	–	P	PU, OP, AL	VO L	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	Ende d
2B	Physician based surveillance system for occupational respiratory diseases (PROPULSE)	CA — QU	Montreal Public Health Department, Occupational and Environmental Health Unit	DC	Y	WRR D	–	–	P	CP, AL	VO L	M	Worker's age, sex, tobacco smoking, occupation, type of industry, causal agent suspected by reporting physician, whether patient was covered by	–	–	–	–	–	–	–	1992	1993

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													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	VO L	2 M	Surname and first initial, sex, age, city or town of residence, job, type of industry, suspected agent	Y	–	–	–	–	–	–	1991	1992
2B	Voluntary registry of occupational respiratory diseases in Asturias, Catalonia and Navarre	ES	Instituto Navarro de Salud Laboral (INSL)	–	Y	WRR D	–	–	P	PH	VO L	2 M	Sex, age, smoking status, workplace where disease occurred, work sector, occupation, suspected causal agent, estimated probability of certainty of	–	–	–	–	–	–	–	2002 (AS, CAT, NA)	2004 (AS)

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													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	
2B	Observatoire National des Asthmes Professionnels (ONAP2)	FR	French Institute for Public Health Surveillance (InVS)	DC, PR	Y	WRA	–	–	P	OP, CP	VOL	–	Worker's gender, age, date and place of birth, occupational title and sector of professional	Y	EXPC	–	–	–	–	Y		2008	Y

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													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	VOL	–	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	–
2B	Italian Occupational Cancer Monitoring Information System (OCCAM)	IT	National Institute for Occupational Health (ISPESL), Italian National Cancer	DC, PR	Y	OCA	–	–	P	ILC, CCS	VOL	–	Medical data from cancer registries/regional hospital discharge records, employment histories, consisting of	Y	–	LIT	–	Y Publications	–	Y	2000	–

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			Institute in Milano										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 text question about accident	–	–	–	–	Y	–	Y	1996	–
2C	iReport; one-stop reporting platform for occupational accidents,	SI	Ministry of Manpower (MOM)	DC	Y	PL	All, no SE, D W,	Y	P	PH, EMP, WO	OB	-	Demographic characteristics and administrative information on	Y	EXP	EXP	–	–	–	–	2006	–

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	injuries and diseases						DEF						patient, details on OD, exposure									
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	–
3A	NIOSH Health Hazard Evaluation (HHE) Program	USA	National Institute for Occupational Safety and Health (NIOSH)	PR, NER	Y	All	–	–	P	EMP, WO	VOL	–	Administrative information on employee, workplace name and address, work description, number of employees, exposure, information on person responsible for employee health and safety at	WI	EXPC	EXP	Y	Y Website, searchable database, preventive actions	Y	Y	1971	–

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													workplace, exposure levels, health outcomes, controls present (engineering, administrative, and personal protective equipment)									
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 description, industrial sector, exposure, protective measures and equipment, work-relatedness	Y	EXPC	EXP LIT	Y	Y Case reports	Y	Y		2013	–
3A+	OccWatch: Occupational Diseases Sentinel Clinical	FR	Research organisation, Modernet network	AW	Y	All	–	N	P	PH OP	VOL	–	Demographic characteristics, principal disease and comorbid	Y	EXP	EXP LIT	Y	Y	Y	Y		2013	–

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	Watch System project		(Monitoring Occupational Diseases and Emerging Risks New Network)										diseases, principal exposure and other possible exposures, occupational title and sector of professional activity, additional informative documents					Relevant stakeholders				
3A+	GAST: Occupational Health Warning Groups	FR	French Institute for Public Health Surveillance (InVS)	AW	Y	All with focus on unusual events	F	N	P	Any one	VOL	–	Diagnosis or symptoms, number of cases, occupational exposure of cases, demographic information in enterprise/public institution	Y	EXPC	EXP	Y	–	Y	Y	2008	–
3A+	Notifiable Occupational Disease System (NODS)	NZ	WorkSafe New Zealand	AW PR RS	Y	All	–	N	P	PH, OHN, EMP,	VOL	–	Name, age, gender of patient, details regarding occupational disease, exposure, industry, work-	Y	EXPC	EXP	N	Y Reports	Y	Y	1992	–

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										WO			relatedness, employer									
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 Prevention (CDC)	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-relatedness information)	Y	EXPC	–	–	Y Newsletters	Y	–	1987; California — 1992	–
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	DC, ST, RS	Y	Pesticide related illness	11 US States	N	P	PH	–	–	Surveillance staff members collect additional information related to individual cases	–	–	–	–	Y Case reports	–	Y	–	–

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			Pesticides Programs (OPP), American Association of Poison Control Centers (AAPCC)																			
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	–	Ended
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	–

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3B	Solvent Panel	NZ	Department of Labour (DoL)	REV	Y	WRDs related to solvents	–	N	P	Cases from registers	VOL		Notified information combined with detailed occupational and exposure histories gathered through interviews with patients and workplace inspection (if necessary)	Y, WI	EXPC	EXP	–	Y Case studies	–	–	–	Ended
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

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
4A	Self-reported Work-related Illness survey (SWI) (module of the Labour Force Survey (LFS))	UK	–	DC, ST	N	All	–	N	A	WO	VOL	QUA	Information on disease, symptoms, exposure, occupation, economic sector, work absence	Y	N	N	N	–	N	–	2001	–
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	–
4B	Pesticide Illness Surveillance Program (PISP)	USA	California Department of Pesticide Regulation (CDPR)	PR, DC, RS	N	Acute pesticide-related illnes	–	–	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
						s and 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	VOL	–	Gender, age, date/place of birth, occupational title and sector, exposures, diagnosis, symptoms	Y	–	–	–	–	–	–	2002	–
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	VOL	–	Worker's gender, age, date and place of birth, occupational title and sector, address, workplace address, exposures, duration of exposure, diagnosis	Y	–	–	–	–	–	–	1998	–

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
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	–	–	–	–	–	–	–	–

* 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 = infectiologist, 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

7 Appendix B – 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

8 Appendix C – Qualitative interviews: topic list and list of interviewees

Topic list for qualitative interviews

- History of the system, including the reasons for its development
- Goals and objectives of the sentinel or alert system (for example statistics, compensation, prevention)
- Actors in the system (for example owner, reporting parties, assessors, data analysts, stakeholders)
- Groups covered by the system (for example all workers, sectors, SMEs, general population)
- Health problems addressed (for example all diseases, one disease or subset of diseases)
- Workflow in the system
- Data input into the system (what data are collected?)
- Outcomes of the system (what information does the system provide?)
- Drivers and facilitators of the implementation and use of the system
- Obstacles and barriers to the implementation and use of the system
- Steps taken/to be taken to cope with obstacles and barriers
- Current use of data in practice (for identification of work-related ill health and risks, exposed groups, sectors and occupations, prevention, reporting, monitoring, priority setting in research)
- Examples of use of data in practice, with a focus on the detection of new WRDs and health risks and need for developing preventive measures
- Possibilities to enhance the use of data for the detection of new WRDs and health risks
- Possibilities to enhance the use of data for the development of preventive measures
- Transferability of the system to other countries
- Existing knowledge gaps/necessary additional research
- If available, an indication of the costs for developing the system and for maintenance after implementation

Overview of interviewees per system

Name of system	Country	Interviewee	Affiliation
SUVA	Switzerland	Dr Claudia Pletscher	Head of Department, Suva Occupational Medicine Department, Lucerne, Switzerland
SUVA	Switzerland	Dr Dieter Kissling	Occupational Physician and Head of Ifa (Institut für Arbeitsmedizin), Baden, Switzerland
SUVA	Switzerland	Dr Hanspeter Rast	Head of Sector Occupational Medicine Specialists, Suva Occupational Medicine Department, Lucerne, Switzerland
THOR	United Kingdom	Dr Melanie Carder	Project Manager and Research Fellow, Centre of Occupational and Environmental Health of the University of Manchester, United Kingdom
THOR	United Kingdom	Dr Louise Hussey	THOR-GP Project Manager, Centre of Occupational and Environmental Health of the University of Manchester, United Kingdom
THOR	United Kingdom	Dr Dil Sen	Clinical Senior Lecturer and Honorary Consultant in Occupational Medicine, Centre of Occupational and Environmental Health of the University of Manchester, United Kingdom

Name of system	Country	Interviewee	Affiliation
THOR	United Kingdom	Dr Raymond Agius	Professor of Occupational and Environmental Medicine, Centre of Occupational and Environmental Health of the University of Manchester, United Kingdom
MALPROF	Italy	Dr Guiseppe Campo	Head of the Unit 'Surveillance systems and integrated risk management' of the Department of Occupational and Environmental Medicine, Epidemiology and Hygiene, INAIL
MALPROF	Italy	Dr Gabriella Madeo	Occupational Physician, ASL Umbria, Dipartimento di prevenzione, Servizio epidemiologia
MALPROF	Italy	Dr Alberto Baldasseroni	Occupational Health Expert, Centro regionale infortuni e malattie professionali (CeRIMP) Regione Toscana, Firenze
RNV3P	France	Dr Gerard Lasfargues	Deputy Director General for Scientific Affairs, ANSES, Paris, France
RNV3P	France	Dr Vincent Bonneterre	Head of Occupational Diseases Consultations Centre, Grenoble Teaching Hospital, Public Health Department, Grenoble, France
RNV3P	France	Isabelle Vanrullen	Occupational Health Expert responsible for the RNV3P at ANSES
SIGNAAL	Netherlands/ Belgium	Dr Annet Lenderink	Occupational Health Expert, responsible for SIGNAAL at the Netherlands Center for Occupational Diseases, Coronel Institute, AMC Amsterdam, Netherlands
SIGNAAL	Netherlands/ Belgium	Stephan Keirsbilck	Occupational Physician, Regional Medical Director at IDEWE Occupational Health & Safety Service – IDEWE, Belgium
SIGNAAL	Netherlands/ Belgium	Dr Nicole Palmen	Senior Researcher, Industrial Hygiene and Occupational toxicology, National Institute for Public Health and the Environment, Bureau Reach, Bilthoven, Netherlands
SENSOR	USA	Dr Geoffrey Calvert	Team Leader, Epidemiology Surveillance Team, Surveillance Branch, Division of Surveillance, Hazard Evaluations and Field Studies, NIOSH, CDC Cincinnati, Ohio, USA
SENSOR	USA	Dr Joanne Bonnar Prado	Epidemiologist, Office of Environmental Public Health Sciences, Washington Department of Health, Olympia, Washington, USA
SENSOR	USA	Dr Elizabeth Evans	Environmental Protection Specialist, Health Effects Division, US Environmental Protection Agency, Washington, DC, USA

9 Appendix D – Additional systems methodologies to identify work-related diseases in Spain: non-compensation-related systems for data collection and statistics

In Spain, Royal Decree 1299/2006, of 10 November 2006, approved the current list of occupational diseases in the social security system and the criteria for their notification and registration, and established the obligation of physicians of the national health system and the prevention services (OSH practitioners) to communicate to the health authorities those diseases that they suspect could be classified as occupational.

The aim of this regulatory measure was to minimise under-reporting of ODs.

There are currently several initiatives to develop systems for the notification of suspected ODs in the 17 autonomous communities of Spain. The result is a wide variety of information and epidemiological surveillance systems about WRDs, which are not directly comparable to each other, but share a common set of elements (García Gómez et al., 2017).

Ten autonomous communities have developed a suspected OD (WRD) notification system, three of them supported by specific regional legislation. The notifiers are physicians in the public health services, physicians in the prevention services and, in two cases, medical inspectors. Seven autonomous regions have specific software to support the system.

For the definition of case and inclusion criteria, eight autonomous communities use the official OD list and two of them (Navarre and Valencia) have established a limited number of diagnostic categories for ODs that require notification. Specific programmes were also observed in two autonomous communities: the Programa de Vigilancia Epidemiológica en Salud Laboral en Navarra/Occupational Health Surveillance Programme in Navarre (OHSP), which involved the communication of six diagnostic categories with high specificity and short latency, and EVASCAP in Asturias, which studied and analysed sick leave due to cancer, to investigate if the disease was caused by work.

The OD recognition rates of suspected cases for the compensation system were 53 % in the Basque Country, 41 % in Castile-La Mancha, 36 % in Murcia, 32.6 % in Valencia and 31 % in La Rioja (García Gómez et al., 2017).

Asturias, the Basque Country and Valencia have regulated their systems through specific regional legislation.

In addition to the OHSP described in this report (section 3.2.2), three additional developed systems in Spain are described below.

- **Asturias**

EVASCAP was created and regulated by the resolution of 14 June 2011 of the Regional Health Administration and the Industry and Employment Regional Administration. It is a programme for detecting and communicating occupational cancer based on sick leave due with a diagnosis of cancer. A register of occupational cancer in Asturias (cancERT) has also been created. In September 2013, 456 cases had been studied, of which 23 were classified as occupational diseases (5 %), 57 as work-related diseases (WRD) (12.5 %) and 378 as diseases not related to work (82.9 %). The National Institute of Social Security proceeded to a change in in the classification of eight cases of cancer, granting the qualification of occupational disease.

Among the main strengths of EVASCAP, its leaders highlight the creation of a cancer assessment team by the regional government; the collaboration of the health and labour authorities in risk prevention; the participation of the Department of Health and the Regional Institute of OSH in the assessment of cases; and the investigation of cases by the Regional Institute of OSH and the systematic registration of all sick leave due to a common disease with a diagnosis of cancer included in the OD list.

The 2015 EVASCAP report is by García Fernández and Rodríguez Suárez (2015).

- **Basque Country (País Vasco)**

In 2008, CSEP was launched in the Autonomous Community of the Basque Country. The system, which is attached to the Inspectorate of Department of Health and to Osalan (the Basque Institute of Safety and Occupational Health), has a double objective: on the one hand, to improve recognition of compensated ODs, encouraging physicians of Osakidetza (the Basque Health Service) and OHS practitioners to identify and report pathologies that may have a work-related origin and, on the other hand, to serve the epidemiological surveillance of non-compensated work-related diseases.

The system has three main actors: the doctors who initiate the notification of cases, the public administrative body, which is in charge of the reception and investigation of cases – Health Inspectorate and the Occupational Health Unit of Osalan (OHU) – and the final recipients of the notifications, which are the mutual insurance body for work-related injury and occupational disease insurance and the National Social Security Institute. Although the system was aimed both at medical practitioners in the Basque Health Service and at occupational healthcare doctors in the prevention services, in the first three years it was mainly fed by the latter. In 2011, when the system connected electronically with the clinical history of Osakidetza, there was greater involvement of primary care physicians and specialists from the Basque Health Service.

The CSEP system has an interoperability device to facilitate electronic communication between the different actors. The Basque Health Service has implemented the electronic medical record in all its services, which allows it to warn a doctor when a diagnosis may have a work-related origin and to report it. In 2017, the information system called Minimal Set of Data of the Prevention Services was implemented through an internet application. This application allows occupational healthcare practitioners to communicate suspected occupational diseases as well as other WRDs. The target of the system is the whole population of the Basque Country aged 16 or over, regardless of whether they are in work, unemployed or retired.

The system has a list of possible pathologies to declare. This list is more restricted for physicians in the public health service than for occupational health practitioners. In the restricted version, 96 possible diagnoses have been included, but 33 have been selected as preferential and are those in which the system alerts the doctor. In prevention services, the system is more open and allows the notification of a wide variety of work-related health disorders. Mental disorders are excluded from both lists.

Upon receipt of the communication into the CSEP system, the public administrative body carries out a first validation of the case and the OHU obtains information on the exposure in the workplace to the agent or agents responsible. If the individual is in work, this information is provided by the occupational healthcare practitioner. For retired people or in cases of some specific diseases such as cancers, the investigation is directly carried out by the OHU. All the cases in which the existence of a work-related potential causal agent is verified are transferred to social security bodies. These organisations are responsible for recognising and treating occupational diseases.

With the aim of strengthening the CSEP system, in 2011 an information campaign was conducted, targeting five medical specialties and primary care physicians in Osakidetza.

A second round was planned for 2018. Osalan has a continuous training plan for OHS practitioners, which includes training in the identification and communication of WRDs.

In the period from 2008 to 2016, 6,752 cases of occupational disease were reported, 88 % from OHS practitioners and 12 % from physicians in the Basque Health Service. Since 2013, there has been a decreasing trend in the number of reported cases, which in 2016 amounted to 587 cases (Garrido, Idiazabal & López Echaniz, 2017). Out of the total number of cases received in 2016, 520 were passed to social security insurance bodies for recognition as ODs, 81 % in men and 19 % in women. Regarding the most frequent type of pathology, almost 50 % were hearing disorders due to noise, 20 % cumulative trauma disorders, 16 % pneumoconiosis, 5 % malignant tumours and 4 % asthma.

The notification rate in 2016 was 31 cases per 100,000 people. The positive predictive value or percentage of communications finally recognised as occupational diseases was 54 % in men and 38 % in women.

The CSEP system contributes to the improvement of EP recognition. The Basque Country has the second highest rate of declaration of ODs in the whole of Spain, and the highest for cancers recognised as ODs. The CSEP system is serving to increase the recognition of pathologies with a long latency period, which appear when the worker is retired. In this regard, in 2016 the CSEP system reported 84 cases of pneumoconiosis and 27 work-related cancers.

Currently, the CSEP system is being consolidated as a main component of the occupational health information system in the Basque Country and is working on improving coordination with social security bodies, on strengthening identification and communication by the physicians in the Basque health service, and on enhancing the rate of feedback to notifying doctors.

- **Valencia (Comunidad Valenciana)**

SISVEL includes the notification of work-related diseases, and was developed by the health administration of Valencia (General Directorate of Public Health of the Department of Universal Health and Public Health). It is regulated by law and helps physicians in the public health service and OSH practitioners to comply with the legal obligation to communicate those diseases that could be classified as work-related (WRDs).

The communication is done electronically, through a computer application, by more than 500 OSH practitioners through a web portal, and the doctors of the public health centres by integration the SISVEL with the assistance information systems, which contain the individual medical records. The system collects all the information generated and sends the relevant data to the occupational health units in the health administration (or other organisations depending on their responsibilities).

The communication of the possible cases from the public centres begins with an alert in the computerised clinical history, to which physicians must respond. From the list of occupational diseases, the 75 most medically relevant diagnostic categories have been selected (Santolaria Bartolomé, Esteban Buedo & Casanova Vivas, 2010). When one of these is diagnosed, the system reminds the doctor that this health problem could be classified as an OD in people over 16 years old and that the doctor has a legal duty to communicate it, and asks if the doctor considers or suspects that it is an OD and wants to declare it as such. It also gives a reminder of the clinical and work criteria established by consensus for this disease for classifying it as OD (Esteban Buedo et al., 2014). If the physician considers that it is an OD and wants to communicate it, the case is sent to the corresponding occupational health unit of the health administration. If the doctor only suspects that it could be OD, he or she is offered help from the occupational health unit of the relevant public health centre, before communicating it to the General Occupational Health Unit.

The help offered is studying occupational exposure to support the suspicion of the work origin of the disease, with the help of the worker, the enterprise's OSH representative(s) and the Labour Administration, if necessary.

The notifying physician can see from the clinical history the information about the stages and results of the process, to inform the worker, change the reason for the sick leave and so on. The doctors from the medical inspectorate and the social security system have access too, through profiles of specific users.

Therefore, SISVEL, in addition to being a communication system for suspicion of ODs and WRDs, acts as a support system for physicians and establishes a communication channel between the public health system, the occupational risk prevention system and the social security system. It also allows epidemiological studies and detection of spatio-temporal clusters of cases.

The implementation of the new system has been progressive. Started in 2010 as a pilot experience, in 2011 it was extended to the 770 public primary care centres and the OSH practitioners' portal was opened, with a reduced list of 35 diseases. Currently it is integrated with all the primary care services and with the main hospitals, covering 100 % of the population.

In order to reinforce the use of SISVEL, information activities have been carried out from the beginning. In 2010 and 2011, related productivity objectives were included for primary physicians and a guide for the communication of work-related diseases was published and distributed. These actions continue, now focused mainly on improving cancer and pneumoconiosis communications, and productivity goals in 2017 and 2018.

Regarding the results, SISVEL is established and is recognised as an effective system for the detection of ODs and WRDs, and is having a considerable impact on official statistics, which reflect a progressive increase in detection rates (Kieffer, 2015). In Valencia, during 2016 a total of 4,193 WRDs were reported through SISVEL, an increase of 12 % compared with 2015. Most communications came from physicians in public health centres (95.28 %) and only 3.36 % from OSH practitioners, percentages similar to previous years. The overall rate was 116.99 cases per 100,000 population aged 16 years or older (15.38 % higher than the previous year). The percentage is somewhat higher in women, 70 %, than in men, 67 %. In 58 % of the cases reported, the occupational health unit (Esteban Buedo et al., 2016) was requested to study them.

In 2016, a total of 2,897 cases were derived to the mutuas (social security system), 69 % of the total number of communications received. Only 33 % of the cases sent to the mutuas were considered ODs, with large differences between mutuas, ranging from 15 % to 65 %. By sex, the percentage of acceptance as ODs was higher in men (37 %) than in women (31 %).

This increase in the declaration of WRDs is reflected in an increase in ODs declared to the national system (CEPROSS). In 2016, a total of 3,090 cases were declared (41.9 % in men and 58.1 % in women), an increase of 10 % on the previous year. In the 2012-2016 period, the number of ODs recognised in Valencia tripled. This increase was greater in women than in men.

Among the advantages of this health system, we highlight the early detection and communication of this health damage, which allow prevention to be promoted.

Participation throughout the development process of SISVEL should be highlighted. The design, implementation and follow-up was done with the collaboration of representatives of the Labour Administration, the professional associations of occupational medicine and nursing, family and community medicine, the social stakeholders (business and union organisations) and OSH practitioners.

An especial highlight is the good level of collaboration among the 10 occupational health units active in Valencia, which have had to adapt their computer systems to receive and respond to SISVEL (Esteban Buedo & Santolaria Bartolomé, 2015).

The current lines of work are aimed at increasing the sensitivity of the system, to detect health problems that are less often communicated, especially cancers and respiratory diseases; increase communications from OSH practitioners; improve the consistency of communications derived from occupational health units and increase their level of acceptance; and combat territorial and gender differences in communication and recognition of occupational diseases.

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13 Appendix H - Abbreviations

ADR	Adverse drug reaction
ANSES	Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail (French Agency for Food, Environmental and Occupational Health and Safety)
ARS	Agence Régionale de Santé (Regional Health Agency, France)
BAuA	Bundesanstalt für Arbeitsschutz und Arbeitsmedizin (Federal Institute for Occupational Safety and Health, Germany)
CPP	Centre de consultation de pathologie professionnelle (occupational diseases consultation centre, France)
CDC	Centers for Disease Control and Prevention, USA
CEPROSS	Comunicación de Enfermedades Profesionales en la Seguridad Social (Occupational Diseases Registry of the Social Security System, Spain)
CHU	Centre hospitalier universitaire (teaching hospital, France)
CIRE	Cellule interrégionale d´épidémiologie (Regional epidemiological unit, France)
CNAM	Caisse Nationale d´Assurance Maladie (French national health insurance fund)
CNAMTS	Caisse Nationale de l'Assurance Maladie des Travailleurs Salariés (French national health insurance fund for employees)
CNT	Carbon nanotube
CO	Carbon monoxide
COEH	Centre of Occupational and Environmental Health (University of Manchester)
CSEP	Comunicación de Sospecha de Enfermedad Profesional (Communication System for Suspected Occupational Diseases, Spain)
CSO	Central Statistics Office (Ireland)
CTS	Carpal tunnel syndrome

DCM	Dichloromethane
DGOS	Direction générale de l'offre de soins (General directorate for care, France)
DGUV	Deutsche Gesetzliche Unfallversicherung (German Statutory Accident Insurance)
Direccte	Direction régionales des entreprises, de la concurrence, de la consommation, du travail et de l'emploi (Regional directorate for enterprise, competition, consumer affairs, labour and employment, France)
DMIPA	Dimethyl-isopropanol-amine
DoL	Department of Labour (New Zealand)
EELAB	Electronic, Experiential Learning, Audit and Benchmarking (United Kingdom)
ENM	Engineered nanomaterial
EPA	Environmental Protection Agency (USA)
EpiNano	French Registry of Workers Handling Engineered Nanomaterials, France
EU	European Union
EU-OSHA	European Agency for Safety and Health at Work
EVASCAP	Equipo de Valoración de Sospecha de Cáncer Profesional del Principado de Asturias (Evaluation of Suspected Professional Cancer, France)
FEDRIS	Federal Agency for Occupational Risks, Belgium
FEV1	Forced expiratory volume in one second
GAST	Groupes d'Alerte en Santé Travail (Occupational Health Warning Groups, France)
GP	general practitioner
HHE	Health Hazard Evaluation, USA
HSA	Health and Safety Authority, Ireland
HSE	Health and Safety Executive, United Kingdom
ICD	International Classification of Diseases

INAIL	Istituto nazionale Assicurazione Infortuni sul Lavoro (National Institute for Insurance against Accidents at Work, Italy)
INRS	Institut national de recherche et de sécurité (French National Research and Safety Institute for the Prevention of Occupational Accidents and Diseases)
INSL	Instituto Navarro de Salud Laboral (Institute of public health and labour of Navarre, Spain)
InVS	Institut de veille sanitaire (French Institute for Public Health Surveillance)
ISPESL	Istituto Superiore per la Prevenzione e la Sicurezza del Lavoro (National Institute for Occupational Health, Italy)
LFS	Labour Force Survey
MALPROF	MALattie PROFessionali (Professional diseases surveillance system, Italy)
MCP	Les maladies à caractère professionnel Surveillance programme of work-related diseases (France);
MIG	Missions of general interest
MLM	Multilevel model
Modernet	Monitoring Occupational Diseases and tracing New and Emerging Risks in a NETwork
MOSS	Musculoskeletal Occupational Surveillance Scheme for Rheumatologists
MSD	Musculoskeletal disorder
MSHA	Mine Safety and Health Administration, USA
NAV	Norwegian Labour and Welfare Organization
NCOD	Netherlands Center for Occupational Diseases
NCvB	Netherlands Center for Occupational Diseases
NHL	Non-Hodgkin lymphoma
NIHL	Noise-induced hearing loss
NIOSH	National Institute for Occupational Safety and Health, USA

NLI	Norwegian Labour Inspection Authority
NODIS	Network of Occupational Disease and Injury Services, Taiwan
NODR	National Occupational Disease Registry, Netherlands
NODS	Notifiable Occupational Disease System, New Zealand
OCCAM	OCcupational CAncer Monitoring, Italy
OccWatch	Occupational Diseases Sentinel Clinical Watch System
OD	Occupational disease
OH	Occupational health
OHS	Occupational health service
OHU	Occupational Health Unit
ONAP2	Observatoire National des asthmes professionnels (Programme for Surveillance of Professional Asthma, France)
OPP	Office of Pesticide Programs, USA
OPRA	Occupational Physicians Reporting Activity
Osalan	Instituto Vasco de Seguridad y Salud Laborales (Basque Institute of Safety and Occupational Health, Spain)
OSH	occupational safety and health
OSHA	Occupational Safety and Health Administration, USA
OSSA	Occupational Surveillance Scheme for Audiological physicians, United Kingdom
OWRAS	Ontario Work-Related Asthma Surveillance, Canada
PANOTRATSS	Patologías No traumáticas de la Seguridad Social causadas por el Accidente de Trabajo (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)
PBZ	Personal breathing zone

PCC	Poison control centres
PEL	Permissible exposure limit
PIM	Peilstation Intensief Melden (Surveillance project for intensive notification, Netherlands)
PISP	Pesticide Illness Surveillance Program, USA
PMSI	Programme médicalisé du système d'information (Medical information system programme, France)
PNSM	Programme national de surveillance du mésothéliome (French National Mesothelioma Surveillance Program)
ppm	parts per million
PRR	proportional reporting ratio
QNHS	Quarterly National Household Survey, Ireland
QSAR	Quantitative structure activity relationships
R&D	Research and development
RADS	Reactive airway dysfunction syndrome
RAS	Registry of work-related diseases (Norway); Register for Arbeidsrelaterte Sykdommer
REL	Recommended exposure limit
RIDDOR	Reporting of Injuries, Diseases and Dangerous Occurrences Regulations, United Kingdom
RIVM	Netherlands National Institute for Public Health and the Environment
RNV3P	National occupational illness surveillance and prevention network (France); Réseau national de vigilance et de prévention des pathologies professionnelles
SABRE	Surveillance of Australian Workplace Based Respiratory Events
SAD	Stress, anxiety or depression
SENSOR	Sentinel Event Notification System for Occupational Risks, USA
SHARP	Safety & Health Assessment & Research for Prevention, USA

SHE	Sentinel health event
SIDAW	Surveillance of Infectious Diseases at Work, United Kingdom
SIGNAAL	Signalering Nieuwe Arbeidsgerelateerde Aandoeningen Loket (Signalling new occupational disorders, Belgium and the Netherlands)
SISVEL	Sistema de Información Sanitaria y Vigilancia Epidemiológica Laboral (Health Information and Epidemiological Surveillance System in Occupational Health, Spain)
SMEs	Small and medium-sized enterprises
SORDSA	Surveillance of Occupational Respiratory Diseases in South Africa
SOSMI	Surveillance of Occupational Stress and Mental Illness, United Kingdom
SUVA	Schweizerische Unfallversicherungsanstalt (Swiss National Accident Insurance Fund)
SWI	Self-reported work-related illness, United Kingdom
SWORD	Surveillance of Work-related and Occupational Respiratory Disease, United Kingdom
TCE	Trichloroethylene
TGIC	Triglycidyl isocyanurate
THOR	The Health and Occupation Reporting Network, United Kingdom
THOR-ENT	Occupational Surveillance of Otorhinolaryngological Disease, United Kingdom
EPIDERM	Occupational skin surveillance, United Kingdom
THOR-GP	The Health and Occupation Reporting Network for General Practitioners
TiO_2	Titanium dioxide
WRDs	Work-related diseases
WRMSD	Work-related musculoskeletal disorder

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.

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