

ALERT AND SENTINEL APPROACHES TO DETECT WORK-RELATED DISEASES

THOR – The Health and Occupation Reporting Network, United Kingdom

This discussion paper is part of a series aiming at describing alert and sentinel approaches for the early detection of work-related diseases (WRDs) in order to provide more insight into the way these systems function and into the drivers of and obstacles to the implementation of such systems. This article describes the Health and Occupation Reporting network (THOR) in the United Kingdom and is based on EU-OSHA's project 'Alert and sentinel approaches for the identification of work-related diseases in the EU' (EU-OSHA, 2018) consisting of a literature review and an in-depth qualitative study and commissioned to a research team made of experts from the Catholic University of Leuven, the Coronel Institute, the Finnish Institute of Occupational Health, the University of Manchester and the University of Bologna.

Introduction to the approach

The Health and Occupation Reporting network (THOR) comprises several schemes, two of which cover all types of WRDs reported by general practitioners (GPs) (THOR-GP) or occupational health (OH) physicians (Occupational Physicians Reporting Activity (OPRA)), and two that are intended for reporting specific groups of diseases: work-related skin diseases diagnosed by dermatologists (EPIDERM) or infectious diseases identified by infectiologists (Surveillance of Infectious Diseases at Work (SIDAW)). In addition, THOR-EXTRA allows all reporting physicians to report interesting cases or WRDs with a potentially novel cause.

Summary of main characteristics

- THOR is maintained by the University of Manchester.
- THOR currently represents the main national OSH data source.
- THOR-EXTRA is the most recently implemented scheme.
- Experts at the University of Manchester constantly assess and analyse the data reported to the THOR monitoring schemes.
- In addition to identifying incidences and trends in work-related ill health in the United Kingdom, the collected data are used in numerous other ways: disseminated to stakeholders, for informing of policies and links with prevention, for identifying new/emerging WRDs, for evaluating preventive actions already in place, etc.
- Data quality is constantly improved through the system's various innovative features.

Initiating organisation

THOR was initiated and financially supported by the United Kingdom Health and Safety Executive (HSE). The HSE is a non-departmental public body of the United Kingdom that is responsible for the encouragement, regulation and enforcement of workplace health, safety and welfare, and for research into occupational risks in England, Wales and Scotland. The HSE's work covers a varied range of activities, from shaping and reviewing regulations and producing research and statistics, to enforcing the law. As regards OSH research and statistics, the HSE gathers data on work-related ill health from three monitoring systems: THOR, the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR) and Self-reported Work-related Illness (SWI) (a module of the Labour Force Survey (LFS)). All three systems are completely independent of the compensation system in the United Kingdom. However, they also work independently from each other and are based on different concepts. RIDDOR is based on obligatory reporting of occupational diseases (ODs) by employers, who are provided with a list of diseases (which is very similar to the United Kingdom's list of prescribed diseases) to report to the HSE, or the local authority when they have been informed by a medical practitioner that an employee is suffering from a reportable disease. SWI gathers data for three-month periods through

interviews with (randomly selected) workers. During these interviews, workers can report any work-related health problems, based on their self-perception. At the time when RIDDOR was the main source of OSH statistical data, THOR was developed to complete the existing epidemiological figures in the United Kingdom.

History of the approach

THOR was initiated in 1989, when the first scheme, Surveillance of Work-related and Occupational Respiratory Disease (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 main objective of the HSE's interest in developing this kind of monitoring system was to address the gaps 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 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.

In the years following the launch of the SWORD scheme for respiratory diseases, several other schemes were implemented. 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 began: Surveillance of Infectious Diseases at Work (SIDAW).

In the following years, four more schemes were established. These 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). At a certain point, the HSE no longer provided 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 the 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. It also 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 collect 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 complementary information about more severe cases, especially in the case of work-related respiratory and skin diseases, which are 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 finding these diseases because the specialist schemes were discontinued.

The most recently implemented scheme is specifically designed for reporting interesting cases or those with a potentially novel cause (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 1 United Kingdom: 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
THOR for General Practitioners (THOR-GP)	GPs	2005	-
THOR-EXTRA	Reporting parties from all other schemes		-

Programme's aim and objectives

Over time, THOR has become the principal source of OSH data for the whole of the United Kingdom, complemented by the information gathered by the other two systems (RIDDOR and SWI). The data gathered by these three systems are occasionally compared and triangulated, in order to obtain the most representative and realistic image of OSH trends 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 requests in which the HSE, THOR reporting parties or other parties ask for specific data (concerning, for instance, a specific economic sector). 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 programme's workflow and reporting

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 in 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.

Most of the schemes (SWORD, EPIDERM, OPRA and THOR-GP) have 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' parties reporting 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 the '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.

Work-relatedness evaluation

Generally, the final decision on work-relatedness is made by the reporting physicians, and each reported case is not necessarily further investigated. 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 the reporting physicians with additional information. 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 clarification regarding the work-relatedness of the reported case.

Reporting mechanism

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 (e.g. 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 leader 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.

Communication

The reporting parties and the researchers who assess the cases constantly communicate. In cases of doubt 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 further used to export data into the SPSS software and perform different statistical analyses.

3. Dissemination

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>

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>

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. The reports also 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.

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

Specific data can also be analysed upon ad hoc data requests from different parties (e.g. 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.

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 cost 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. The financial support to begin the SWORD scheme came from the HSE, which has since then also partially provided 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 began: SIDAW.

Costs do not grow with the addition of each scheme, as many core activities are not influenced by the number of schemes. However, data on the budget proposals at different phases of the system show that, 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 the year 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 through which the HSE can 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, etc. 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** to help inform their decisions. For instance, they are a source of evidence for 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 that enabled the 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 'reporter fatigue'.

Below are some other concrete examples of how THOR data are used for informing policy and prevention.

- 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>
- THOR data have 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 allergies, 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>);
- 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 HSE produces *Inspection Topic packs*, which provide advice to inspectors. Its pack on the *Control of isocyanate exposure in motor vehicle repair (MVR) body shops* 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* 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 detecting new/emerging WRDs

Even though THOR was primarily designed to provide OSH statistical data, it 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, etc. These cases are usually **described in 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 cyanoacrylates 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 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 through the SWORD database (Jarvis et al., 2005). 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, many methodological challenges arose, which led to the **development of sophisticated statistical methods**. This includes methodological advances with regard to determining disease 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). 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 reporters, seasonal patterns in reporting, a decrease in reporting over time due to 'reporter fatigue', etc. Another issue addressed by THOR is potential biases in the population covered by THOR towards specific industries, as exemplified by occupational health physicians (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 implemented in the United Kingdom by law. After this, THOR data were analysed, and they 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 or not they considered the cases to be work related. Surprisingly, psychiatrists were more likely than OH physicians to consider a case to be work-related, 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 in their day-to-day tasks, the 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' information was limited to only the person with health complaints. These data contributed to a better understanding of how physicians handle diagnostic information.

Occasionally, some **industries and SMEs have been interested in obtaining 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.

Stakeholders' views

This article is partly based on qualitative, in-depth face-to-face or telephone interviews with four stakeholders of the system. The interviews reflect the views of different actors in the system (e.g. owner of the system, workplace actor reporting it, and researcher or other stakeholder using the resulting data from the system) on the drivers and obstacles (Table 1), the quality of data and the transferability to other countries of the system or approach.

Drivers and obstacles

Drivers	Obstacles
<p>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</p>	<p>Difficulties in keeping physicians engaged. They are mainly caused by time constraints, increasingly busy schedules and the growing demands in clinical practice. An important means to cope with this obstacle is to simplify the reporting procedure as much as possible.</p>

Drivers

developed and implemented (e.g. 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 (reporting party): 'For someone who's been a core reporting party for many, many years, I get more out of THOR than I actually put in.'

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.

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 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 that on the prediction of asthma hazards, provide additional opportunities for funding in those contexts.

Data quality

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

Obstacles

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're always looking at new ways; for example, we're thinking about trying to develop a reporting application. Just ways to make the process as simple and quick as possible really.'

They also mentioned delegating the reporting task to nurses or a group leader who reports for several people as a possible way forward.

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.

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've 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, 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) when 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 the physician does about it, how the loop has 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's 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 difference 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, the interviewees agreed this 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 conditioning factor for establishing this kind of monitoring system.

7. References

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▪ Links for further reading

Presentation on RNV3P at the meeting on MySignal.be at [Fedris](https://www.fedris.be/sites/default/files/assets/NL/Presentaties/nisse_vanrullen_31mars2017_defv4.pdf), 31 March 2017 in Brussels (BE). https://www.fedris.be/sites/default/files/assets/NL/Presentaties/nisse_vanrullen_31mars2017_defv4.pdf

Presentation by Professor Raymond Agius on THOR at the EU-OSHA project workshop in Brussels on 18 May 2017. <https://osha.europa.eu/sites/default/files/seminars/documents/THOR%20system%20presentation%20Agius.pdf>

A [literature review report](#), the [final report](#) and [summary report](#) of the EU-OSHA's project 'Alert and sentinel approaches for the identification of work-related diseases in the EU', as well as two summaries of two seminars ([18 May 2017 in Brussels \(BE\)](#); and [31 January 2018 in Leuven \(BE\)](#))

and the presentations given at the seminars are available from :

<https://osha.europa.eu/en/themes/work-related-diseases/alert-and-sentinel-systems-osh>