Health and hazard surveillance — needs and perspectives

Author(s): Timo Kauppinen and Jouni Toikkanen

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Health and hazard surveillance — needs and perspectives[1]

by Timo Kauppinen, PhD,[2] Jouni Toikkanen, MSc[2]

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Health and hazard surveillance is the on-going collection, analysis, evaluation, and dissemination of information aimed at improving the health, work ability, and well-being of workers. Hazard surveillance supplemented by quantitative risk assessment is the most prevention-oriented domain of surveillance. However, information on exposures and stress factors is often lacking. Computer-assisted expert judgment is a new approach to improve knowledge on hazards. Surveillance of work organizations and psychosocial factors is a challenging area which still requires research. Statistics on occupational injuries and diseases are available, but nonspecific coding and insufficient interpretation often limit their usefulness. Systematic surveys of new types of cases and the linking of different data bases are becoming more feasible. Methodological work is needed to develop indicators of work ability and work-related symptoms. Among the many possibilities to develop surveillance are the use of information technology, the application of hazard communication principles, and the development of practical aids for surveillance at the company level.

Key terms epidemiology, exposure, monitoring, review, work organization.

The surveillance of occupational hazards and health has been described in several previous reviews (1—4). Interest in surveillance has been on the rise especially in the 1990s when economic recession threatened to limit resources available for occupational health activities in many countries. Registers, interview surveys, and other surveillance information systems have the potential to produce information on the state and trends of occupational hazards and risks to target limited resources effectively to achieve maximal preventive effect. Recent international products on surveillance include the guidelines of the International Labour Organisation (ILO) for workers' health surveillance (5), data of the World Health Organization (WHO) for the Health for All by the Year 2000 program (see reference 6 or http://www.who.dk) and an initiative to develop surveillance indicators (7). At the European level, the European Agency for Safety and Health at Work (Bilbao, Spain) is gathering comprehensive data on the state of occupational safety and health in the European Union to be disseminated mainly through the Internet (http://europe.osha.ev.int). Statistics on accidents at work (the ESAW project, see reference 8) and occupational diseases (the EODS project, see reference 9), the second European Survey on Working Conditions (ESWC) (10 or http://europe.osha.int/statistics), the estimation of carcinogen exposures at work (the CAREX project, see reference 11 or http//www.occuphealth.fi/list/data/CAREX), the description of surveillance data bases (the HASTE project, see reference 12 or http://www.occuphealth.fi/e/eu/haste), and the survey of availability of surveillance data (13) are other examples of activities within the European Union. National surveillance projects are also many, and they produce information to be used mainly by occupational health and safety authorities, experts, and researchers to guide their activities. Companies and workplaces may also have their own health and safety surveillance activities as part of the quality system or separately.

This review first discusses the concept of surveillance, comments then on the basic methods and approaches used, and then presents recommendations to develop the surveillance of occupational hazards and health. The national level of surveillance and the role of research institutions in surveillance are emphasized.

1 This review is partially based on a working group report (reference 4).

2 Finnish Institute of Occupational Health, Helsinki, Finland.

Reprint requests to: Dr Timo Kauppinen, Finnish Institute of Occupational Health, Topeliuksenkatu 41 a A, FIN-00250 Helsinki, Finland. [E-mail: Timo.Kauppinen@occuphealth.fi]

Basic concepts

Surveillance aims at evidence-based decision making in the prevention of occupational hazards. It is multidisciplinary activity drawing, for example, from epidemiology, statistics, occupational medicine, industrial hygiene and psychology, sociology, and communication theory. There is neither a uniform theory nor an established definition available on surveillance. The concepts in occupational surveillance have been discussed in several publications (1—4, 14).

One way to summarize the approach, target population, aim, and coverage of surveillance is the following (4): occupational health and hazard surveillance is the on-going collection, analysis, evaluation, and dissemination of information aimed at improving the health, work ability, and well-being of the labor force (employed and unemployed). Health surveillance involves producing and examining indicators of mortality, work disability and ability, occupational diseases and injuries, other work-related diseases, work absenteeism, symptoms, and the like. Hazard surveillance observes topics like mechanical, physical, chemical, microbiological, ergonomic and physiological, psychosocial, and life-style factors. Information is needed also on factors related to health and hazards, such as the structure of the labor force and the performance of occupational safety and health systems.

Surveillance is essentially a process (figure 1). It starts from data collection from various sources (registers, interview surveys, case reports, measurement data bases, etc). Data are usually computerized, analyzed statistically, and displayed in tabular or graphic forms providing distributions, time trends, sums, means, or other statistics. This phase is often followed by the interpretation and evaluation of the significance of findings carried out by experts familiar with the subject matter. The process should continue through evidence-based decision making on the direct prevention, dissemination of information, training, research, or other activities considered to be desirable.

The resources for surveillance are always limited as compared with the potential extent of the field. Therefore the approaches and methods applied should be regularly assessed and modified before the next data collection efforts. Ideally the surveillance process is a loop which develops continuously in a more informative and cost-effective direction.

Surveillance uses methods developed in epidemiology but also differs from it. Epidemiology studies primarily unconfounded relationships between outcomes (health) and determinants (hazards). Its ultimate goal is to identify and quantify abstract relationships. Surveillance has the same object of research, but its emphasis is on the state, distribution, and trend of outcomes or of

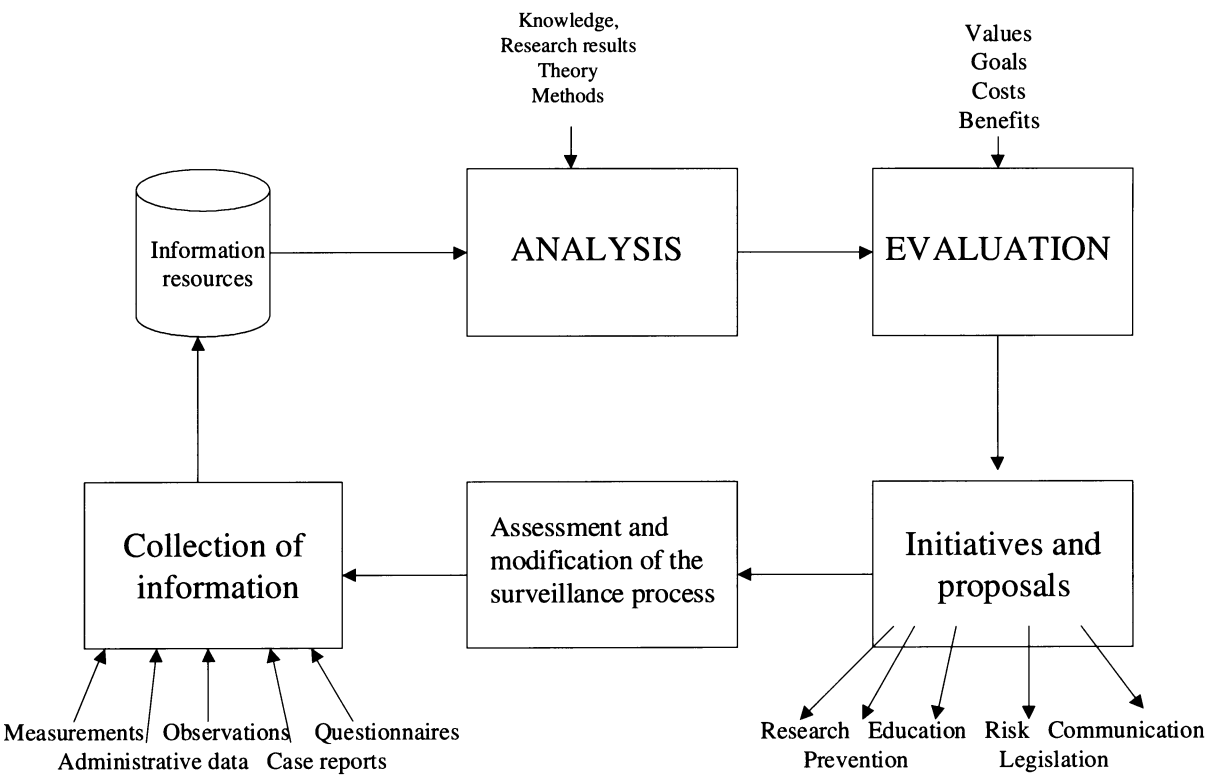

Figure 1. The surveillance process.

determinants, rather than on their relationship. The goals of surveillance are not abstract but, instead, particularistic (time and place specific). In contrast to epidemiology well-controlled study designs are seldom possible in surveillance. Therefore the validity and reliability of indicators, as well as the assessment and control of confounding factors, are intrinsic challenges in surveillance.

Hazard surveillance

Hazard surveillance is the most prevention-oriented domain of surveillance, especially when followed by quantitative risk assessment. If epidemiologic studies provide quantitative exposure-response relationships and surveillance provides quantitative prevalences and levels of exposure in a population, it is possible to predict and localize attributable cases due to exposure, which is a good basis for targeting preventive measures. Unfortunately we are still far from this ideal situation.

Typical approaches in hazard surveillance are industrial hygiene measurement and biomonitoring data bases, interview surveys, field surveys, exposure registers, and expert judgment-based exposure information systems as a novel approach.

Industrial hygiene measurement and biomonitoring data bases

Measurement data bases are maintained in many countries by research institutes, enforcement, or companies. (See, eg, references 15—16.) Recommendations for their core information have been published (17). These data bases provide an overview of exposure levels and their trends. However, information is often based on compliance measurements from a selected sample of workplaces, and it usually varies from year to year and therefore makes the results unrepresentative and difficult to interpret. Large measurement data bases are laborious to maintain because of their comprehensive coding requirements. Sometimes data are also difficult to computerize (eg, graphs), and therefore the recording is complicated, especially for physical exposures. The potential of measurement registers to aid the identification of work tasks entailing high exposure levels may be insufficiently utilized. This type of "alarm" information is essential for prevention, and its dissemination to workplaces should be strengthened. Workplaces also need information on feasible preventive measures to control excessive exposures. This information is often lacking from measurement data bases. Information on the substitution of hazardous chemicals (18) and on other practical preventive measures (19) is available, and sharing of this type of information, for example, through the Internet would be desirable. The work load in the maintenance of measurement data bases can be diminished by limiting the coding to the minimum and complementing it with an electronic archive of measurement documents allowing search by words and strings.

Interview and questionnaire surveys

Interview surveys on work conditions are carried out in many countries and areas. Examples of them are NHANES (National Health and Nutrition Examination Survey) in the United States, ESWC in the European Union, and national surveys in the Nordic countries. They provide information on the prevalence of exposure to some physical agents, ergonomic factors, physiological factors, psychosocial factors, and life-style factors. They are usually based on a representative sample of the working population. Agents which are not easily recognizable, such as chemical and biological exposures, are difficult to survey with interviews or postal questionnaires. The main problem of self-reported exposure information is its subjectivity. Agent and exposure can be understood differently by different respondents. Trends over time can reflect a true change in exposure or a mere changing awareness or attitude. The validity and comparability of results can be improved if questions are standardized and the frequency, duration, and intensity of exposure are inquired about rather than its general occurrence. Methods for surveying ergonomic and physiological factors at the workplace level have been reviewed (20).

Field surveys

Examples of field surveys on the occurrence of exposure are the National Occupational Hazard Survey (NOHS) in the United States (US) in 1972—1974, the US National Occupational Exposure Survey (NOES) in 1981—1983 (21, 22), the SUMER survey (Surveillance médicale des reiques professionnels) in France (23), exposure surveys in Denmark (24, 25), and an on-going survey in Israel. The strength of field surveys is that they are based on representative, stratified samples of workplaces, and the resulting data can therefore be used to estimate the numbers of exposed workers and the occurrence of products used at the national level. A weakness of field studies is that they usually provide no information on exposure levels, and therefore risk assessment and the targeting of preventive measures are difficult. Subjectivity may also be a problem, especially when low or infrequent exposures are recorded. Field surveys are also laborious, slow, and expensive to carry out because they require a large number of workplace visits and traveling. Industry-specific field surveys can be considered as an alternative strategy. Because they can be focused on high-risk industries only, the validity of exposure information can be improved by standardizing observational procedures and adopting semiquantitative assessment methods. The possibility to enter data on site in a laptop computer is

likely to speed up data processing in all field studies. There is also a need to develop easy-to-use personal computer programs for safety and health personnel carrying out field surveys or other surveillance activities at workplaces.

Registers of exposed workers

Registers of exposed workers are rare. One example is the Finnish Register on Occupational Exposure to Carcinogens (26). The objectives of this register are to stimulate the identification, assessment, and prevention of carcinogenic exposures at workplaces, to target safety inspections, to enable targeted training and dissemination of information, and to enable national follow-up of occupational cancer risks. The employers are obliged to notify exposed workers annually to a national register. There is some evidence that the effect of the register is preventive, but the magnitude of this effect is unknown. There is an unwelcome possibility that the notification will become a routine duty over time. Another disadvantage is that the register does not focus on true high-risk groups because the minimum level of exposure is low and inaccurately defined. On the other hand, it is difficult to ensure that all heavily exposed workers are notified. This register is currently under evaluation.

Expert information systems as a surveillance method

A novel approach to hazard surveillance is to combine professional judgment and available measurement, survey, and other data. An example of this is the Finnish job-exposure matrix (FINJEM Exposure Information System)(27). This approach is able to provide quantitative information on exposure prevalences, levels, and numbers of exposed workers by period, agent, and occupation. FINJEM covers major chemical, physical, microbiological, ergonomic, and psychosocial factors occurring in Finland. It was constructed with the help of about 20 experts who entered relevant background data on the labor force and exposure into a data base and assessed accurately defined exposures according to a uniform procedure. This data base, which includes comprehensive documentation, is planned to be updated every 3 years. It has been used for surveillance purposes, in large epidemiologic studies (eg, in register-linkage studies), and as a general multipurpose data bank on exposures.

Surveillance of psychosocial factors and work organizations

Continuity and flexibility in adaptation to rapid changes of worklife is a major challenge to work organizations. Lean organization structures, teamwork, quality management approaches, the use of information technology, and the use of temporary workers are some of the responses.

The surveillance of work organizations is becoming increasingly important for the well-being of workers as many traditional hazards are slowly decreasing. On the other hand, psychosocial stress factors, unconcerned safety attitudes, defects in communication, and the like can result in traditional hazards.

Interview surveys are the most common method with which to collect surveillance information on psychosocial factors (4). The following 3 types of factors are usually covered: (i) workload factors, such as haste at work, difficult decisions and threat of violence, (ii) related health outcomes, such as burnout, psychosomatic symptoms and stress hormones, and (iii) factors which modify the relationship between work load and health outcomes, such as control possibilities and social support at work.

Currently there is a lack of information on the organizational characteristics of workplaces and their changes. A combination of psychological and sociological approaches may turn out to be fruitful in future research on work organizational factors, which form perhaps the most challenging area of surveillance, where indicators, survey methods, and the interpretation of results still require research to provide more practical and valid information.

Health surveillance

Occupational health surveillance is a wide field covering outcomes such as mortality, work disability and work ability, occupational diseases, occupational injuries, work-related diseases, work absenteeism, and work-related symptoms. The surveillance of occupational health is presented in the following discussion by outcome.

Occupational injuries (accidents at work)

Statistics on occupational injuries and accidents are collected in almost all countries for worker compensation and preventive purposes. Definitions and notification practices are often based on regulations, and statistics are published annually. The coverage of statistics may be a problem, especially when an accident causes only a minor injury leading to a short absence from work or no absence. The use of statistics and related data bases for risk identification and prevention could often be strengthened. A prerequisite for this step is that the basic information on causes and injury be reported and coded accurately. Reports on fatal and other severe injuries include additional valuable descriptive information and recommendations helpful in preventing similar accidents elsewhere. Case registers and the sharing of information on cases and feasible solutions, for example, through the Internet, could benefit prevention although data protec-

tion and patient confidentiality regulations may limit the dissemination of information. Other means to enhance injury surveillance are data-set linkage studies and the development of company-wide surveillance systems (28).

Occupational diseases

Occupational diseases are usually regulated in the same way as occupational injuries, and statistics are produced annually in most countries. National legislation, diagnostic practices, and notification procedures strongly influence the statistics. The comparability of data across countries is often poor (9). However, statistics are used mainly for national purposes and the potential to produce appropriate information for the compensation and prevention of diseases is more relevant than intercountry comparability. The value of comparative statistics is in its ability to reveal gaps in the identification of occupational diseases and to stimulate the discussion of the appropriateness of national legislation and practices. The validity and completeness of data are also influenced by the training and instructions provided for physicians. Because the identification of occupational diseases is more complicated than that of accidents, incomplete and nonspecific notifications may limit the usefulness of surveillance. Electronic data transfer may decrease losses and improve the quality of data in the future. Data entry to a surveillance information system requires the specific and accurate coding of diagnoses, exposures, occupations, and industries to enable the identification of groups of workers at high risk and the targeting of preventive measures. Specific reporting and coding are also keys to the identification of new occupational diseases and the sharing of information about them.

Occupational mortality

The tradition in the surveillance of occupational mortality is long. The statistics on causes of death have been analyzed by occupational title from death certificates or from the national census at least in the United Kingdom, the United States, and the Nordic countries. The computerization of records has opened new possibilities to combine large national data sets. One example is a Finnish project in which data from censuses, the mortality register, the work disability register, the occupational disease register, the hospital disease register, the FINJEM exposure matrix, and the occupation-lifestyle matrix were linked to form a research data base allowing the long-term surveillance and study of the Finnish population (29).

Occupational disability

Pension statistics have been analyzed by occupation and diagnosis at least in the Nordic countries (4). The work-relatedness of back pain, mental disorders, and heart diseases can be studied from work disability data. As with occupational diseases, the state and trends of work disability depend significantly on national legislation and practices.

Occupational morbidity

The concept of work-related diseases includes occupational diseases, which are predominantly caused by occupational exposure, and other diseases to whose etiology or development work contributes. Such diseases include musculoskeletal diseases, mental disorders, circulatory diseases, respiratory diseases, and cancer. The occurrence of work-related diseases and their determinants (age, gender, occupation, etc) can be studied through interviews or questionnaire surveys or through registers (disease-specific registers, hospital discharge registers). In particular surveillance methods for musculoskeletal symptoms and diseases have been developed during the 1990s (20). Work-related and occupational diseases can be surveyed in the same way as communicable diseases, through a network of individual health care providers. A system called Sentinel Event Notification System for Occupational Risks (SENSOR) was launched in the 1980s in some states of the United States (30). Case reports of work-related conditions are analyzed by a central state agency, which also coordinates follow-up and intervention activities to prevent occupational diseases. This approach has been applied, for example, to silicosis, asthma, pesticide poisoning (31), lead poisoning, and carpal tunnel syndrome (32). The SENSOR approach is an alternative and complementary method with which to study work-related and occupational diseases if registers and surveys are unsatisfactory.

Work-related symptoms

The analysis of symptoms reported in interview or questionnaire surveys may reveal new or existing risks at work. However, because "nonoccupational" symptoms are common, attention needs to be given to the collection of precise information on symptom frequency and severity to identify work-related symptoms (33).

Work ability

The mean age of the labor force is increasing in many western countries. Work ability has become an important summarizing concept in efforts to avoid early retirement of the aging labor force. Work ability can not only be considered to include physical health, psychosocial well-being, and professional competence of individuals, but also appropriate work environment and work organization, which improve the performance of people at work (34). The work ability index (WAI), which is based on a person's opinion of his or her own work ability, diseases diagnosed by a physician, and sick leave during the past year, has been found to predict future work disability and early retirement (35, 36). Because the index was devel-

oped in the context of a study on aging Finnish municipal workers, its validity needs be tested in other populations. The work ability index and other measures of work ability have potential use at the company level as measures of the state of human resources, which is said to be the most important success factor for an enterprise in the era of the "information society".

Recommendations

The previous sections of this article have reviewed the state and outlined some directions in which to develop methods and approaches in the specific domains of surveillance. In addition, there are some general perspectives and needs which have been addressed, for example, by a Nordic working group (4). The recommendations of that group can be summarized as follows.

First, the surveillance of occupational hazards, health, and their relevant background factors should be intensified in response to rapid and complex changes in worklife. Rational priority setting and effective prevention require factual and fresh surveillance information. Surveillance should cover all relevant areas of occupational safety and health (ie, health outcomes, hazards, life-style, and their determinants, eg, the structure of the labor force, and health and safety provision).

Second, various feasible data sources and methods should be utilized. Population-based methods (eg, registers and interviews or questionnaire surveys) are the backbone of surveillance, but their information needs to be supplemented by case-based surveillance (eg, case and cluster observations) to identify new hazards as early as possible. Accurate coding of exposures, diagnoses, occupations, and industries should be encouraged to enable the identification of worker groups at high risk.

Third, modern information technology (world wide web, electronic mailing lists, newsgroups, etc) provide new opportunities with which to collect and disseminate surveillance information. Networking and the interactive exchange of information are expected to increase. Links to other information systems, including case-information and information on good preventive measures are already possible.

Fourth, additional information should be collected, especially on the occurrence of hazards and on work organizations. More hazard data on the numbers of persons exposed, mean levels, and high levels are needed, but it is a challenge to develop cost-effective measurement and survey strategies. Exposure information systems based on expert judgments supported by available measurement and survey data may be useful tools with which to summarize relevant hazard information. More data are also needed on the characteristics and structure of work organizations, which may profoundly modify work and work conditions.

Fifth, valid and feasible indicators should be developed and used. International standard procedures would improve the comparability of information across countries, although comparability over time may, however, be more important at the national level, where surveillance information is being used for preventive purposes.

Sixth, statistical data should be interpreted by experts who are familiar with occupational health and hazard issues and can identify possible biases in the production of statistics. An interpretation of data and an evaluation of their significance by competent persons are also desirable to help decision makers draw the correct conclusions.

Seventh, more computerized surveillance tools applicable at the company and workplace level should be developed. There is a need for easy-to-use tools for workplace surveillance (eg, on psychosocial factors and work ability).

Eighth, the trend analyses of surveillance data can be supplemented by visions and scenarios to facilitate the prediction of future health problems.

Ninth, surveillance systems and methods should be periodically evaluated and modified so that limited resources can be allocated efficiently for the prevention of occupational risks and the promotion of workers' health. New methods and approaches may be needed to detect new phenomena, and the use of existing methods should be critically assessed.

The future vision and objective of surveillance could be a uniform surveillance information system that is comprehensive, valid, up-to-date, easy-to-use, and continuously developing. Regular analyses of surveillance information by competent persons followed by targeted and rapid dissemination of information, and surveillance-based action planning in all institutions involved in labor safety and health is likely to be one of the most efficient strategies with which to increase the effectiveness of preventive measures and the promotion of workers' health.

References

1. Baker EL, editor. Surveillance in occupational health and safety. Am J Public Health 1989;79 supplement.
2. Halperin W, Baker EL, Monson RR, editors. Public health surveillance. New York (NY): Van Nostrand Reinhold, 1992.
3. Stellman SD. Record systems and surveillance. In: Stellman JM, editor. Encyclopedia of occupational health and safety; vol I. 4th ed. Geneva: International Labour Office, 1998: chapter 32.
4. Tüchsen F, editor. Surveillance of the working environment and health: concepts and sources of information. Copenha-

gen: Nordic Council of Ministers, 1998. TemaNord 527.
5. International Labour Office (ILO). Technical and ethical guidelines for workers' health surveillance. Geneva: International Labour Office, 1997. MEHS/1997/D.2.
6. World Health Organization (WHO), Regional Office for Europe. Printout of HFA database and some other data available in the WHO Regional Office for Europe. Copenhagen: WHO, Regional Office for Europe, 1994.
7. Takahashi K, Aw TC, Koh D, Wong TW, Kauppinen T, Westerholm P. Developing national indicators for occupational health [commentary]. Scand J Work Environ Health 1997;23:392—3.
8. Eurostat. Accidents at work in the European Union in 1993: initial results. Eurostat 1997. Statistics in focus 1997/2.
9. Laursen P, Netterstrøm B, Gyntelberg F, Jørgensen K. Reporting occupational diseases in the European Community, phase I: final report. Copenhagen: 1992.
10. European Foundation for the Improvement of Living and Working Conditions. Second European survey on working conditions 1996. Luxembourg: Office of Official Publication of the European Communities, 1997.
11. Kauppinen T, Toikkanen J, Pedersen D, Young R, Ahrens W, Boffetta P, et al. Occupational exposure to carcinogens in the European Union. Occup Environ Med. In press.
12. European Foundation for the Improvement of Living and Working Conditions. The European Health and Safety Database (HASTE). Summaries of descriptions of systems for monitoring health and safety at work. Dublin: European Foundation for the Improvement of Living and Working Conditions, 1995.
13. Nossent S, de Groot B, Verboon F, Pantry S. European working environment in figures: availability and quality of occupational health and safety data in sixteen European countries. Dublin: European Foundation for the Improvement of Living and Working Conditions, 1996.
14. Halperin WE. The role of surveillance in the hierarchy of prevention. Am J Ind Med 1996;29:321—3.
15. Smith MH, Glass DC, The availability of occupational exposure data in the European Community. Luxembourg: Office for Official Publications of the European Communities, 1993. EUR 14378.
16. Greife A, Young R, Carroll M, Sieber W, Pedersen D, Sundin D, et al. National Institute for Occupational Safety and Health general industry occupational exposure databases: their structure, capabilities, and limitations. Appl Occup Environ Hyg 1995;10:264—9.
17. European Foundation for the Improvement of Living and Working Conditions. Occupational exposure databases: a proposal for core information for workplace exposure measurements on chemical agents. Dublin: European Foundation for the Improvement of Living and Working Conditions, 1996.
18. Sorensen F, Styhr Pedersen HJ. Substitution of hazardous chemicals and the Danish experience. Occup Hyg 1995;1:261—78.
19. Swuste P, Corn M, Goelzer B. Hazard prevention and control in the work environment, report of a WHO meeting. Occup Hyg 1995;1:325—8.
20. Kuorinka I, Forcier L, editors. Work related musculoskeletal disorders (WMSD): a reference book for prevention. London: Taylor and Francis, 1995: chapter 5: Health and risk factor surveillance for work related musculoskeletal disorders.
21. Seta J, Sundin D, Pedersen D. National occupational exposure survey; vol I (Survey manual). Cincinnati (OH): National Institute for Occupational Safety and Health, 1988.
22. Sieber W. National occupational exposure survey; vol II (Sampling methodology). Cincinnati (OH): National Institute for Occupational Safety and Health, 1990.
23. Heran Le Roy O, Sandret N. Enquête nationale SUMER 94, premiers résultats [National survey SUMER 94, preliminary results]. Paris: Ministère du Travail et des Affaires Sociales, 1996.
24. Brandorf NP, Flyvholm MA, Beck ID, Skov T, Bach E. National survey on the use of chemicals in the working environment: estimated exposure events. Occup Environ Med 1995;52:454—63.
25. Seedorf L, Olsen E. Exposure to organic solvents I: a survey on the use of solvents. Ann Occup Hyg 1990;34:371—8.
26. Kauppinen T, Savela A, Vuorela R. ASA 1990 — employees exposed to carcinogens in Finland in 1990: reviews 18. Helsinki: Finnish Institute of Occupational Health, 1992.
27. Kauppinen T, Toikkanen J, Pukkala E. From cross-tabulations to multipurpose exposure information systems: a new job-exposure matrix. Am J Ind Med 1998;33:409—17.
28. Sorock GS, Smith GS, Reeve GR, Dement J, Stout N, Layne L, Pastula ST. Three perspectives on work-related injury surveillance systems. Am J Ind Med 1997;32:116—28.
29. Notkola V, Pajunen A, Leino-Arjas P. Occupational mortality by cause in Finland 1971—1991 and occupational mobility. Helsinki: Statistics Finland, 1997. SVT health 1997:1.
30. Baker EL. Sentinel event notification system for occupational risks (SENSOR): the concept. Am J Public Health 1989;79 suppl:18—20.
31. Maizlish N, Rudolph L, Dervin K. The surveillance of work-related pesticide illness: an application of the Sentinel Event Notification System for Occupational Risks (SENSOR). Am J Public Health 1995;85:806—11.
32. Maizlish N, Rudolph L, Dervin K, Sankaranarayan M. Surveillance and prevention of work-related carpal tunnel syndrome: an application of the Sentinel Event Notification System for Occupational Risks. Am J Ind Med 1995;27:715—29.
33. Wegman DH. Investigations into the use of symptom reports for studying toxic epidemics. In: Rantanen J, Lehtinen S, Kalimo R, Nordman H, Vainio H, Viikari-Juntura E, editors. New epidemics in occupational health. Helsinki: Finnish Institute of Occupational Health, 1994:124—38. People at work, research reports 1.
34. Ilmarinen J. Aging and work – coping with strengths and weaknesses [editorial]. Scand J Work Environ Health 1997;23 suppl 1:3—5.
35. Tuomi K, Ilmarinen J, Jahkola A, Katajarinne L, Tulkki A. Work ability index. Helsinki: Finnish Institute of Occupational Health, 1998.
36. Eskelinen L, Kohvakka A, Merisalo T, Hurri H, Wägar G. Relationship between self-assessment and clinical assessment of health status and work ability. Scand J Work Environ Health 1991;17 suppl 1:40—7.