

All research in the field of occupational health and safety should serve preventive purposes, directly or indirectly. In contrast to many other diseases, work-related disorders can indeed be prevented, and therefore prevention must always be foremost when research priorities are set for work-related disorders. In the occupational environment primary prevention almost always implies interference, not with the workers, but with harmful work conditions, be they accident risks, chemical, physical or biological hazards, physical strain, or mental load. Yet it would be wrong to say that primary prevention is entirely a nonmedical activity, something for engineers, hygienists, ergonomists, psychologists, or sociologists alone.

There is a long way to go before enough knowledge has accrued to render action meaningful at the national or even shopfloor level. In national health policies the successful and cost-efficient prevention of adverse health effects requires valid risk assessment. Risk assessment is a process involving several steps. First, the risk factor (what is dangerous) must be identified and its health effects (what type of damage) described. Next the mechanisms of adverse effects (how damage is caused) must be clarified and effect-modifying factors characterized (does the damage become more or less severe in the presence of other factors). The "severity" of the risk must also be known, and therefore quantitative research is needed on exposure-effect and exposure-response relationships (how much exposure causes how much damage; what is the "safe" level). Finally, extrapolations must be made to both the occupational and the public health setting to assess the magnitude of the problem (how many cases of illness). This process, which is necessary for adequate prevention, needs much biomedical, hygienic, psychological, and other research, and, of course, judgment.

At this point the scientific domain ends (although not the contribution of scientists) and the administrative function of risk *management* begins. Administrative aspects include political, economic, and ethical judgments, consensus on what is acceptable risk, the setting of hygienic standards (eg, threshold limit values, maximum allowable concentrations) or the issuing of other prescriptions or recommendations, the evaluation and choice of technical solutions, and the ranking of different problems in terms of urgency. Although the administrative aspects are no longer the *responsibility* of scientists, the *contribution* of researchers to decision making in an advisory capacity is crucial.

At the workplace level prevention can proceed, and usually proceeds, more directly from identifying the hazard to preventing it, without the formal

risk assessment needed for educated national policies, but with a consideration of what is known of mechanisms, exposure-response relationships, and preventive strategies. This awareness may be old "textbook" knowledge, or it may be based on the latest scientific article, but in both cases scientific research has, at some stage, been required.

Hence, although the practical final steps of the preventive process usually rely on engineering and other nonmedical actions, the process of acquiring an understanding of the problem is a multidisciplinary endeavor in which biomedical sciences hold a central position. Medical research is usually crucial for identifying the hazard, for describing its mechanisms, and for quantifying the risk. Risk assessment must also rely on other disciplines, such as epidemiology, statistics, toxicology, occupational hygiene, ergonomics, and psychology. In the safety domain medicine is not that central, but also this field is multidisciplinary, engineers needing the cooperation of psychologists, physiologists, epidemiologists, and ergonomists. It is important that all the experts involved in reaching the final goal of occupational health and safety, which is the successful prevention of hazards, can think together, communicate together, and work together. Thus successful prevention indeed needs much research before any meaningful action can be taken.

Although we usually know too little about a problem, there are instances in which too much research, perhaps of a mediocre quality, confuses the picture. Often, in such cases, scientists favor certain topics, and this favoritism leads to abundant and even redundant research involving endless repetitions of previous work, leaving other areas suffering from a lack of scientific information. Scientists unfortunately all too often lose perspective when digging (too) deep into their own specialty. We can, for example, ask if it is of any practical or even scientific value to study the details of the mechanism by which lead inhibits the *n*'th enzyme, when all the necessary knowledge for preventing lead poisoning exists. Or is it really worthwhile, once again, to carry out a scientific study showing that asbestos causes mesothelioma also in the republic of Backwardia, when we know that it happens in all other countries and when the real issue is prevention? Or, for the hundredth time, should it be established that poor work positions cause shoulder pain when the real issue is to learn how to prevent the pain? Or should we once again determine that mental stress causes stress-related symptoms? My answer is "no."

Another way of looking at research priorities is by subject matter. I have already mentioned some "over-researched" topics, but there are many more. The fact

that classical occupational diseases still occur does not automatically mean that more *research* is needed, for example, using the most sophisticated (and expensive) modern methodology. What it really means is that we have failed to *implement* already existing knowledge. This may not require additional research. On the other hand, there are still severe gaps in our knowledge about a great many occupational hazards — especially if we consider the logical chain from risk identification to risk prevention. Filling these gaps is what research is needed for. Everyone who has been involved in, for example, setting standards or evaluating chemical carcinogenicity or adapting elderly workers to the use of office computer technology, for that sake, knows this.

A recent survey that I carried out among senior researchers at the Finnish Institute of Occupational Health yielded an interesting list of “hot spots” in the different fields of occupational health research. All of them cannot be listed here, but I have selected a few to illustrate the outcome.

In the field of toxicology, the development of molecular biology methods for identifying genetic susceptibility to certain exposures (eg, polymorphism) was recommended. Identifying polymorphic individuals can help sharpen epidemiologic case-referent studies. Another recommendation was to study oncogene or tumor suppression gene mutations and interactions between carcinogen exposure and host factors. Existing biological monitoring methods should be validated and methods for additional chemical substances should be developed. Human biomarkers should be developed for use as hazard indicators, for example, in cancer research.

Reproductive health is now a developing field, and the effects of both xenobiotics and electromagnetic radiation on, for example, paternal fertility, are still not well enough understood. The time-to-pregnancy method should be developed for studying fecundity.

The combined effects of several concomitant exposures, for example, noise, vibration, and chemicals, are interesting, and also individual susceptibility should be considered in the study of physical exposures. Nonionizing radiation, especially electromagnetic fields, and their effects on carcinogenesis and pregnancy outcome need more study.

Many problems involved in shift work are still unsolved, such as factors promoting adjustment to night and shift work, the effect of aging, and how to implement increased flexibility in shift-work arrangements.

In the very important field of preventing musculoskeletal disorders better exposure assessment is needed, and valid exposure-effect studies are lacking. Better standardization of “soft” outcome parameters is also desirable. The problems of the elderly when confronted with modern technology and the ever-increasing other demands at work need much study so that correct modes of action can be defined and recommended. Intervention studies are logisti-

cally difficult in the occupational setting, but they are urgently needed, not the least for finding methods to prevent musculoskeletal disorders and ways to cope with the problems of elderly workers. Methodological development is a requisite for the sound interpretation of the results of both intervention studies and the so-called case studies.

Considering their variation in different settings, the work-related etiologic fractions of many diseases with a multiple etiology, such as cardiovascular diseases, still need quantification. In the study of such diseases the whole life situation must be taken into account, which adds much to the demands for valid study design, especially in the measurement of various “exposures” and potential confounding factors.

Allergic diseases are becoming more and more prominent as occupational health problems. Research has revealed that they occur in numerous occupational settings, and many of them are “new.” Research aiming at risk identification, mechanisms of action, and individual sensitivity is needed. Preventive trials using different methods of protection are desirable.

Epidemiologic studies of work-related cancers face great challenges if they are to provide truly new information in the future, instead of the repetition of others’ work, which is all too prevalent today. One major challenge is the demand for much more valid and detailed exposure data than hitherto. Exposure assessment has indeed improved during the last decade, but much work is still needed. Another demand is the requirement for higher sensitivity, which means larger study populations. Especially, studying low-exposure conditions and “proving” the absence of effects require more sensitivity in research. The solutions, be they mammoth national studies or international multicenter studies, are very expensive.

In psychological research a new trend is emerging. Today the effects of long-term unemployment are becoming as important as those of a poor psychosocial work environment. Maintaining the work ability of young people who are affected by long-term unemployment is one of the greatest challenges. How to cope with mental stress is another, and the mechanisms through which mental stress influences health, for example, with regard to cancer and infectious diseases, need elucidation. Work organizations are nowadays being radically changed, and the effects of organizational transformations on workers must be studied. The concepts of “total quality management” and “continuous quality improvement” are new in the service sector, although both have traditions from industry, and their effects on productivity, competence, and the health of personnel need elucidation. The interactions between professional qualifications and the conceptual mastery of work on one hand and the well-being of the workers, their efficiency, and the capability of handling errors, on the other, have also proved to be a field where much research is needed. The distribution of cognition in

groups of workers, the use of knowledge, and how problem solving is managed can also affect the well-being of group members, and this is a further area in need of more knowledge.

In this 20th Anniversary Issue of the *Scandinavian Journal of Work, Environment & Health* several of these aspects of research have been addressed by outstanding members of the Editorial Board — independently of my small survey, it should be added. There is a strong emphasis on the importance of improved exposure assessment, both for epidemiologic cancer studies, as Axelson and, especially, Kauppinen point out, and for the study of work-related musculoskeletal disorders, as reviewed in Kilbom's article. Biological monitoring has also to do with exposure assessment, although the monitoring of some early effects belongs to the realm of health surveillance. Aitio gives an overview of new techniques that may open new avenues in the future. However, he stresses the need for validating the methods to enable the interpretation of results. Neurotoxicity of metals has been a much researched topic during the last decade, and it may now be time to sum up our knowledge. Wennberg provides a synopsis of what we know today in this field. Neurotoxic effects of solvents is the topic of Hogstedt's review, and he concludes that high solvent exposure in the past indeed could cause functional disturbances of the central nervous system, while current exposure levels, at least in developed countries, are probably not that dangerous. Olsen touches a problem of interest in his review on possibly declining human fecundity. He also points out the problems involved in research in

this field. Knave addresses another problem of current interest, namely, the health effects of electromagnetic fields. Gemne, on the other hand, reviews a topic which has traditionally attracted much research in Sweden and Finland, hand-arm vibration, and he attempts to define where we stand today. Langård shows how risk assessment can be done at the national level, using work-related lung cancer in Norway as an example. Nordman concludes that the time has come to act to prevent work-related asthma, and Rylander describes the prevention of diseases caused by organic dusts, starting with exposure assessment, description of the disease and its mechanisms and ending with recommendations for prevention. In the last review of this special issue Lindström discusses the psychosocial work environment with a strong emphasis on guidelines for how it should be developed.

I hope this special issue will be interesting reading and that the ideas put forward will stimulate research along both these lines and those mentioned earlier in this editorial. During its 20 years of existence the *Scandinavian Journal of Work, Environment & Health* has tried to convey new ideas to its readership and act as a forum for currently interesting research topics from the whole field of occupational health from all over world. Both our authors and our peer reviewers deserve warm thanks for their contributions. I trust that, together, we can develop and further improve the *Journal* along the same lines also in the future.

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