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Risk assessment and the setting of priorities in occupational health and safety

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RANTANEN J. Risk assessment and the setting of priorities in occupational health and safety. *Scand j work environ health* 7 (1981): suppl 4, 84—90. Risk management is a concept central to present-day occupational health and safety. Decisions concerning the regulations of risks are based on the results of risk assessment. To date, no systematic approach to the assessment and management of risk has been developed. The issue is a difficult one because it involves combining scientific analyses with societal and political decision making. It is crucial that the risk assessor and risk manager identify the model according to which risk is regulated in his particular society. This review presents the consecutive steps used to assess risks. Also described is the linking of the assessed risks to the setting of priorities in decisions of risk management.

Key terms: risk acceptance, risk estimation, risk evaluation, risk identification, risk management, risk regulation.

The assessment of risk is a complicated process comprising several related steps: identification, estimation and evaluation. The results of risk assessment are utilized at the societal level when decisions are made about accepting, averting, or modifying risks (21, 28). All of these steps are important in the management of the risks found in society. In the field of occupational health and safety, the methodology of risk assessment is still undeveloped though the effective management of risks requires it. Also necessary is closer linkage between the process of risk assessment (realized by scientists) and the process of decision making (realized by the authorities) (12, 20, 28).

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Risk identification

The first step in the assessment of risk is risk identification, ie, the discovery and definition of the risk associated with a particular activity (12, 28, 30). Risk identification usually provides qualitative and descriptive information about risks, but it does not necessarily provide detailed information about the characteristics of the phenomenon of risk. It can occur separately or in combination with other phases of risk assessment. Risk identification may be carried out, eg, in the following contexts: (i) in the routine monitoring of risk events (outcome), for instance, by analyzing national statistics on mortality, morbidity, accidents, etc; (ii) in the routine monitoring of exposures (eg, by recording hygienic measurements); (iii) when alarms are raised by experts, victims of the consequences of risk, or victims' interest groups (eg, scientists, health personnel, trade unions, associations of the handi-

capped, etc); (iv) on the basis of learning from events which have occurred; (v) on the basis of warning events such as "near accidents"; (vi) as a result of specific risk studies, usually cross-sectional epidemiologic projects; (vii) on experts' intuition based on a priori knowledge (eg, identification of the risk of chemical carcinogenesis based on structural analogy).

The basic idea behind risk identification is to call attention to the existence of risk exceeding the accepted baseline risk level (31). Risk identification is a crucial step of risk assessment. Without it the phases that follow would not be possible. In occupational health and safety, there is as yet no systematic risk identification activity comparable to that of environmental protection (20). To date, the most widely used method has been the cross-sectional epidemiologic study.

The routine monitoring of data, eg, from registers of outcome, is in itself an unsatisfactory risk identification system for several reasons. The "focusing" of risk in small high-risk groups can be masked by the average figures. On the other hand, the information fed into comprehensive registers can be so superficial that it is difficult to identify risk groups — occupation, for instance, is often poorly registered. There are some interesting projects on risk identification now in progress in socialist countries, but the results have not yet been systematically reported (35).

Morbidity is rarely recorded by occupation. Therefore only the final outcome — death — is used for risk identification, and the importance of earlier or less severe consequences is neglected. The most difficult obstacles for risk identification to overcome, however, are the turnover and selection of workers, both of which make it difficult to follow outcomes in relation to exposures (6, 8). The long latency period between exposure and outcome with regard to occupational risks, eg, cancer, constitutes another difficulty. The data systems most important for risk identification in Finland in the field of occupational health and safety are presented in table 1.

Risk estimation

Risk estimation deals with determining the probability of the occurrence of events which involve risk. It is also concerned with determining the consequences of events which involve risk and with determining the associations between causative factors and outcome (12, 20, 28). A detailed

Table 1. Data sources for risk identification in Finland.

Register	Outcome data	Exposure data	Maintenance organization
Vital records (death certificates)	+	Main occupational groups	National Board of Health
Census data (quinquennial)	—	Distribution of labor force by occupation	Central Statistical Office
Hospital discharge register	+	—	National Board of Health
Social insurance registers			
National invalidity pensions	+	Occupation	Social Insurance Institution
Long-term disability	+	—	Social Insurance Institution
Short-term disability	+	—	Social Insurance Institution
Employment pensions	+	—	Pension Care Center
Labor accidents	+	+	National Board of Labor Protection
Congenital anomalies	+	—	National Board of Labor Protection
Cancer	+	—	National Board of Health
Hygienic measurements [a]	—	+	Institute of Occupational Health
Biological monitoring [a]	+	+	Institute of Occupational Health
Carcinogen exposure [a]	+	+	Institute of Occupational Health
Specific exposures, for example, styrene	+	+	Institute of Occupational Health

[a] Only manual at the moment.

qualitative and quantitative determination of risk is achieved with risk estimation. In cases where the outcome is a negative health event, risk is estimated by means of epidemiologic methods. In the most specific meaning of the concept, the cumulative incidence rate provides an estimate of the risk in question (17, 34). In the case of accidents, the probability of risk can be calculated in several ways, eg, by counting the number of accidents occurring within a certain period of time in a certain activity. The logical and methodological procedures used to estimate the risk of accidents have been presented by Rowe (28).

For the risk estimation of a given activity, data for all relevant cases may be difficult to obtain. Various types of extrapolations are necessary in such situations (3, 10, 34). The following are possible methods of extrapolation:

Extrapolation to the future: Future trends of a particular risk phenomenon are extrapolated on the basis of data obtained in the past.

Reverse extrapolation: The causal factors of a hypothetical or real event of the past are traced. Also involved is the reconstruction of the event on the basis of the data obtained.

Analogue extrapolation: This method involves the transfer of data from a similar (though different) situation, or it involves the transfer of data pertaining to the most essential aspect of a comparable situation. The transferred data are then used to assess the risk of the activity in question. An example is the use of a dose-response curve based on data of radiation exposure and tumor response to calculate tumor risk caused by chemical carcinogen exposure (4, 23).

Risk estimation is a scientific process which, in addition to determining the probability of a risk event, comprises the exploration of causative factors or a study of the associations between causative factors and outcome. In the broadest sense, it also requires modeling of the risk phenomenon. The study of the model should reveal risk factors, the mechanisms of risk from the process leading to the outcome, and an analysis of the size, time, and space dimensions of the consequence (12, 20, 28, 30).

As far as the estimation of work-related risks is concerned, estimates based on mortality risk data no longer provide sufficient information for decision making and risk regulation because various outcomes other than death are more frequent and have a higher information value in this context. Therefore, calculating the loss of work years (2, 7, 29) is more relevant for risk estimation than the estimation of mortality risk alone. On the other hand, work years lost by death are also taken into consideration in the calculation of the loss of work years. When compared to the calculation of mortality data alone, this method underestimates the humanistic value of death as the absolute negative event, whereas this disadvantage is balanced by the consideration of the loss of work years in nonfatal cases.

Risk evaluation

Risk evaluation provides social value for an identified, estimated risk. In principle, it is a process of social judgement. It balances negative consequences of a risk event with the social benefit of the particular activity (20). Risk evaluation is a process which always entails the consideration of values, and, therefore, it is a societal process rather than a scientific one. Due to historical reasons, however, scientists and experts tend to control this process, as they are in control of the information needed for it (20).

Depending on the nature of the risk activity and its consequences, the following types of risk evaluation exist:

Comparative risk evaluation: The risk is related to the consequences of another type of activity or to a baseline risk present in society (31).

Risk evaluation based on absolute data: The value of the consequence of a risk, eg, death, is valued as the absolute negative event which is unacceptable in connection with the activity concerned.

Aversive risk evaluation: This type of risk evaluation takes into consideration the social gains obtained by the total elimina-

tion of losses caused by a particular activity — eg, how many lives could be saved by regulating speed limits in traffic (2, 7).

Cost-benefit analysis is often used as the basis for risk evaluation. The following justified criticism of its use has however been presented. The calculation of human life or human health in monetary terms is not accepted by many scientists or institutions (14, 24). Intangible costs and benefits are difficult to calculate in relevant, comparable terms (16, 24). The costs of aversive actions are usually calculated on the basis of possibilities provided by the technology of the present day, without considering the possibility that technical capacity will improve as society develops (1, 11). In the case of long-term effects, the negative consequences of risk cumulate slowly as the decades pass (eg, cancer), and it is therefore difficult to calculate all the costs of an activity involving risk (26).

There is reason to believe that estimating the costs and benefits of preventive occupational health programs is difficult. Overestimation of the costs of preventive programs and underestimation of its benefits are common.

Another common fallacy occurs in the risk evaluation of a technical activity when the health benefits of prevention are underestimated and the economic investments needed to improve safety are overestimated (1, 5, 11, 16, 25).

Psychology of risk assessment

There are several examples to show that, in relation to risk, the general public, workers, and decision makers do, in fact, behave in a manner different than what could be expected on the basis of data on risk assessment. Perception of risk in the process of risk identification varies according to: (i) the context in which a risk is identified, (ii) the impact of the consequence of risk on the social environment in which the identification is made, and (iii) the personal relation of the assessor to the risk phenomenon or to the consequences of the risk phenomenon. On the individual level, the following factors affecting risk perception have been found:

(a) Bloody, concrete risks are perceived more easily than abstract, remote, or nonbloody risks. Thus, the perception of work accidents and chemically induced cancer is different (21, 31).

(b) An individual's previous experience of the consequences of risk influences the perception of risk (21).

(c) An individual's possibility to measure and estimate risk on his own initiative greatly influences the perception of risk (21).

(d) The more active an individual believes himself able to participate in risk regulation, the less he feels that the risk is alarming (32).

Risk perception on the societal level differs from the perception of risk at the individual level in the following ways:

(a) In general, the baseline risk of a society has an impact on the societal perception of risk. The reference risk level has been suggested to be mortality from all diseases (31).

(b) Voluntary and involuntary risks are perceived and accepted differently. Accepted voluntary risks are usually about 1,000 times the level of accepted compulsory risks (31).

(c) The identification and acceptance of risk depends on the benefit gained from the activity which involves risk.

(d) The "risk shift phenomenon" means that a group perceives a risk to be more extreme than an individual does (30).

(e) The level of accepted risk depends on the balance between the creator of risk, the victim of risk, and the authority regulating risk. The actual balance between the various parties depends on the size, political power, and ability of each party to assess and manage risks (21, 27).

Risk identification and evaluation are highly dependent on the psychological background of the assessor, whereas risk estimation is expected to be a more "objective" process (20, 21, 28).

Because risk evaluation is a process entwined with the overall value system of a

society and the values of each society are usually dynamically changing, the reference system of risk evaluation should be seen as unstable in character (28). The long-term trends of the background of risk evaluation are thought to follow Maslow's or Hertzberg's theories of hierarchic needs (9, 15, 24, 28). If this assumption is correct, it has an important impact on the setting of priorities of occupational health and safety. (See the following section.)

Setting priorities

The management of various kinds of risk is one of the most important areas of decision making in the present-day policy of occupational health and safety. Risk management comprises the modification, aversion and acceptance of risks. The question of regulating which risks in what order is an important aspect of the setting of priorities. There are several methodologies for setting priorities in science (36), in public health (7, 22), in occupational health (13), and in environmental protection (20). The Finnish National Board of Labor Protection recently completed a study of the assessment of risks and the setting of priorities of occupational health and safety in Finland (18, 19). Although several methodologies for the setting of priorities are available, intuitive decision making was found to be an important complement of the systematic assessment of risks. The systematic identification and estimation was done on the basis of: (i) results of scientific studies of risks in various branches of industry, (ii) several types of outcome and exposure registers, and (iii) the intuitive evaluations of experienced labor inspectors who, in their everyday work, come into contact with events which involve risk (19).

The criteria used to set priorities can be divided into external (= societal) and internal (= institutional/scientific) criteria (22, 34). The criteria of the two divisions can be classified according to three main headings: *importance, relevance,* and *feasibility. Importance* entails criteria indicating risks with consequences that would affect the overall health and safety of the population. It refers to both the volume of the problem and the intensity of risk involved. *Relevance* indicates the willingness of a society or the scientific community to regulate or analyze the particular risk. *Feasibility* indicates criteria related to the technical, economic, methodological, material, and intellectual capacities of a society or the scientific community to regulate or assess risks.

Importance criteria are measured by risk estimation, whereas both relevance criteria and feasibility criteria are measured, in part, by risk evaluation.

The process of setting priorities and managing risks depends on the basic structure of the process of policy making inherent to a society. Environmental scientists have recognized two models (29), the adversary model (the United States, Japan, West Germany) and the consensus model (Great Britain, The Netherlands, the Nordic countries). The adversary model is characterized by open and public discussion of risks. The risks are regulated by independent, competent authorities who control risks by means of powerful legislation and detailed specific norms. The consensus model entails more confidential closed discussions and negotiations between the parties of society involved; comprehensive "frame-type" legislation constitutes the main influence of the authorities. In this model, practical implementation is controlled by the parties of society which are given high competence together with the authorities.

The methodology of risk assessment and priority setting is better developed in those countries which follow the adversary model, because the public process of risk management involves the element of challenge (20). To date, it is impossible to say which model is more successful. For both the risk manager and the risk assessor, the identification of the model according to which his society regulates risks is of crucial importance.

Provided Maslow's and Hertzberg's theories are applicable in this context, the setting of priorities should be a continuous and dynamic process regardless of the model. The quality of the priorities will develop, simultaneously with the progress of occupational health and safety, in order to satisfy the needs of higher hierarchic levels, once the goals of the lower levels have been attained (24, 28).

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