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THE STRATEGY OF TARGETTED HEALTH SURVEILLANCE
II. GENETICALLY DETERMINED SUSCEPTIBILITY TO CHEMICAL SUBSTANCES AND OTHER ISSUES RELATED TO HEALTH SURVEILLANCE

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Abstract: A number of current issues regarding methods of primary and periodical medical examinations were discussed in view of application of research results in practical activities of the occupational health service.

The review of tests employed on detection of deficiency or peculiarity of biochemical susceptibility to given chemical factors revealed objective causes limiting and delaying, to a certain extent, of practical application of scientific progress in health surveillance. Tests facilitating detection of susceptibility to emphysemagenic factors, genetic markers of atherosclerosis, neoplasm (especially neoplasm of the urinary bladder and lung cancer) were discussed. According to the opinions presented, further advancement of research, as well as application of new methods should, during a relatively short time, dispel existing doubts and accomplish standardization of methods.

The usefulness of psychological tests, now being introduced to health surveillance, was also discussed. It was found that tests may enrich considerably certification of physical fitness for those jobs with high stress levels and requiring a high level of reliability. They are extremely useful in individual assessment of work load, and they allow the detection of early disorders in the central and peripheral nervous system, preceding evident pathology produced by working environment factors.

The most common obstacles in the wide application of the discussed methods include: inadequate post-graduate education of psychologists; the rare combination of two specialisations (psychology of labour and clinical psychology); and a shortage of test methods which have been verified in the conditions of a given country.

This work also raises questions about the health effects of exposure to electromagnetic radiation, complex exposure to toxic substances, health condition and periodical examinations in workers of advanced age.

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INTRODUCTION

The first part of the article published in no 3, 1990 of the Polish Journal of Occupational Medicine, presented opinions on three issues of great social concern and general importance in view of health protection, namely evaluation of the health effects of exposure to carcinogens, malformations and neoplasm in children as a consequence of parents' occupational exposure to harmful factors in the working environment, and reproductive disorders of the same etiology.

As was previously stated, this treatise focuses mainly on the application in health surveillance methods of the detection of genetically determined susceptibility to chemical substances, and the usefulness of psychological tests in the evaluation of physical fitness for work along with the detection of early effects of occupational exposure. Also included are brief comments on the evaluation of the health effects of exposure to electromagnetic fields, complex exposure to chemicals, and issues related to health conditions in workers of advanced age.

GENTICALLY DETERMINED SUSCEPTIBILITY TO CHEMICAL SUBSTANCES

The problem of genetically determined susceptibility to factors occurring in the working environment, and the related need of undertaking genetic investigations in persons who have been working in that environment dates back many years.

Already in 1938 J.B.S. Haldene wrote in his book Heredity and Politics "... the majority of potters do not suffer from bronchitis. It is quite possible that when the cause of this disease is fully understood, we shall be able to find the reason why a certain group of potters have constitutions evoking the sensitiveness to this disease. Thus, we shall be able to eliminate bronchitis in potters through admitting appropriate persons to this profession". Today we know that a pathologic phenotype alpha-1-antitrypsine is one of the causes of early development of bronchitis in potters (and in other professions exposed to dust). It has already been suggested that an attempt be made to phenotype this protein (7,23) during a qualifying examination for work in exposure to emphysemagens.

Despite the fact that some tests facilitating detection of genetically determined changes have been, for years, a part of the qualifying examination for employment – e.g. testing of colour blindness in drivers or atrophy in persons exposed to substances which might cause dermal changes – the question of genetic investigations in workers employed is relatively new, no more than 25 years old. The greatest interest was paid to tests identifying those persons who, due to genetically determined biochemical peculiarities, are especially sensitive to certain chemical substances. Over 90 pharmacogenetic or ecogenetic-defects are known to be related to occupational health. The majority of these defects very seldom occur in the general population; nevertheless, there

Table 1. Assessment of methods proposed as indices of exposure to carcinogens and/or as indices of biological response

Name of the method	Comments on usefulness	Comments on validation criteria
1	2	3
1. Determination of carcinogens' quantity or their metabolites in organic fluids	sufficient technical advancement; in the case of low exposure more sophisticated methods are required; usually specific for individual compounds except determination of thioethers in urine;	adequate for: – assessment of exposition? – assessment of health effect?
2. Determination of mutagenic activities in excrement	non-specific for exposure factor; possible changes in mutagenic activity depending on preparation of samples; possibility of false positive results depending on techniques and quantity of aminoacids in the sample	repeatability and comparability of results
3. Cytogenetic methods facilitating detection of chromosomal aberration, sister chromatids and micronuclei	non-specific for exposure factor; labor-consuming and expensive; usually applied in research; can be used for detection of suspected exposures	– specifity, repeatability – detection limits – in the case of sister chromatids determination of individual internal variability required between non-exposed groups of population (race, sex, age, etc.)

1	2	3
4. Determination of carcinogenic adducts with protein and nucleic acids	can be sensitive and specific for determination of exposure; determination of mixtures with nucleic acids more useful in the risk assessment;	– lack of initial levels; – necessity of identification of causal factors and a quantitative evaluation of risk evoked by them
5. Determination of proliferation or cellular transformation i.e. neoplasm markers	application in treatment and neoplasm diagnostics in general, low specifity and sensitivity (except tumour of endocrine gland) low or non specified predictive value	– at the present stage of development cannot be used in biological monitoring and requires further investigations

is a slight chance that a person with such a metabolic defect could be found among candidates for employment. Other susceptibilities genetically determined either apply to occupational health in a very limited way, or their relation to occupational health has not been clearly indicated. It seems that genetic screening based on biochemical deficiency or peculiarity, proposed by Stockinger and Scheel in 1973 (23) is of the greatest significance (Table 2).

Table 2. Categories of genetic variability in humans

No	Category	Examples
1	Absence of deficiency of essential substance	deficiency of alpha-1-antitrypsine
2	Deficiency or absence of enzymatic system	dehydrogenase of glucose-1-phosphate
3	Change in cellular transportation of metabolite	susceptibility to CS_2
4	Production of abnormal antibodies	antibodies reacting to antigens, evoked by allergy to pollen in hay fever and also to certain chemical substances
5	Presence of abnormal protein	Hemoglobin S in sickle-cell anaemia

It is true that many comments could be made about the classification of genetically determined organic peculiarities, and their true significance in occupational medicine, especially (in certain cases) small occupational exposure. It is hoped that a consultation, organized by WHO-EURO in October 1990, on genetic predispositions to the toxic effects of chemicals will contribute to practical application of test investigations in the detection of over-sensitivity to given chemical factors. Because of the present gap between scientific progress and its practical implementation, none of the proposals made 17 years ago by Stockinger and Scheel could be applied in health surveillance to fill in the gap. To find out the reasons for this phenomenon, it would be advisable to make a thorough study of circumstances determining practical usefulness or uselessness of the proposed screening methods based on two examples. The first one is taken from the publication of Stockinger and Scheel on alpha-1--antitrypsine and the other refers to the testing of family hyperproteinemia. In general, these are important questions in the evaluation of a population's state of health, and especially in the case of human exposure to carbon disulphide.

Reasons why the determination of phenotype and alpha-1-antitripsine have not been applied to prophylactic medical examinations have been identified as the following:

a. low frequency of homozygous deficiency inhibitor (phenotype P and Z below 0.1%);

b. the unproved role of heterozygous deficiency of alpha-1-antitrypsine in the development of pulmonary enphysema, much more often observed in the population;

c. relatively costly and time-consuming methods and requirements, concerning specialised equipment and competence of staff;

d. the probability that another genetically determined factor exists, and affects the development of pulmonary emphysema, manifested by the increased activity of elastase in neutrophils in the peripheral blood (8, 9, 19) and in other cells; and

e. limited share (up to 10%) of genetic determinants, currently known, in the development of pulmonary emphysema including the activity of elastase in neutrophils of the peripheral blood.

Apart from comments presented previously, it should be mentioned that the possibility of determining the antioxidative function of plasma as an index of processes of oxidative inactivation of alpha-1-antitrypsine is being considered for the near future. From the logical point of view, this index corresponds more closely to the occurrence of oxidative factors in the environment. This method is simple and inexpensive (3).

As appears from the analysis of the discussed example, the main problem of transferring of alpha-1-antitrypsine determinations to targetted health surveillance (primary examinations) lies in the explanation of the heterozygous deficiency of this enzyme. Progress in the development of other methods is indispensable in evaluating determined sensitivity to factors causing pulmonary emphysema.

The other example is more complicated in view of present knowledge because of the diverse background of defects in lipoprotein metabolism.

Usually, defects in lipoprotein metabolism, cause both abnormal growth and a decreasing concentration of specific groups of lipids and lipoproteins i.e. chylomicrons, very low density lipoproteins (VLDL), and low density lipoprotein (LDL). Such factors as sex, age, environment, life-style and genetic defects, influence the lipid metabolism. Lipid and lipoprotein defects can be classified into several categories: hyperchylomicronemia (types I and V), hyperlipoproteinemia (types IIa, IIb, III and IV) and HDL deficiencies.

Some of those defects considerably increase the risk of atherosclerosis. Doctors evaluating the risk of atherosclerosis of coronary vessels should take into consideration, first of all, the determination of total cholesterol, triglyceride, cholesterol of HDL fraction and cholesterol of LDL fraction in the blood. Recently, methods of determination and evaluation of apolipoprotein have been developed. For example, apo AT has become an important genetic marker of the development of arterial vessel atherosclerosis. It can be assumed that a more precise analysis of apolipoprotein, DNA, enzymes, receptor and gen will in the future play a considerable part in the diagnosis of lipoprotein disorders.

The review of various types of disorders in lipoprotein metabolism and its

Table 3. Determination of dyslipoproteinemia phenotype and its relationship to genetic disorders

Phenotype	Behaviour of lipids, lipoproteins in plasma					Markers for determined lipoprotein disorders	Name of family dyslipoproteinemia related to genetic disorders	Relationship with atherosclerosis
	Chylom	VLDL	LDL	Cholest	Triglic			
I	↑	–	–	–	↑	Abnormal enzyme	Family LDL deficiency, Apo c-II deficiency	–
IIa	–	–	↑	↑	–	Abnormal receptor, unknown defect	Family hypercholesterolemia family, complex hyperlipidemia	+
IIb	–	↑	↑	↑	↑	Abnormal receptor, unknown defect	Family hypercholesterolemia family, complex hyperlipidemia	+
III	–	–	–	↑	↑	Apolipoprotein deficiency, abnormal apolipoproteins, unknown defect	Family dysbeta-lipoproteinemia	+
IV	–	↑	–	↑	↑	Abnormal apolipoproteins, unknown defect	Family hypertrigliceridemia, family complex hyperlipidemia	+
V	↑	↑	↓	↑	↑	Abnormal apolipoproteins	Family hypertrigliceridemia, family complex hypertrigliceridemia	+

markers, whose determination may be applied in health surveillance, shows their evident progress. Although a portion of the proposed methods of evaluation of family dyslipoproteinemia is now available, their further study is necessary in order to develop proposed markers for future applications (analysis of receptor and gen). But the most important thing is to simplify analytical procedures and to limit the scope to a few markers. The generally observed limitations (total cholesterol and eventually triglyceride) are definitely insufficient.

Undoubtedly, genetically determined sensitivity plays also a significant role in neoplasm incidence.

Edward J. Calabrese reviewed all the issues discussed during the August conference on genetic predisposition to toxic effects of chemicals (2) and he shows, among other conclusions, that the main attention in this regard is focused on:

a. the phenotype of free acetilation, which might be significant in the development of urinary bladder neoplasm in persons exposed to aromatic amines; and

b. genetic differences in the expression of cytochrome P-450; Especially important in the development of lung cancer in smokers, also in provoking neoplasm by 2-acetyl-amino-fluoren, and oxidation of other substances to derivatives, inducing carcinogenesis and mainly nitrosoamine.

Debrosiquine hydroxylation polymorphism (related to the development of bronchial carcinoma) belongs to the latter group of genetic factors.

Among factors determining neoplasm and mentioned above the phenotype of free acetilation will be discussed separately during the Congress. Nevertheless, E.J. Calabrese reveals that implementation of genetic screening (in the practice of health surveillance aimed at detecting sensitivity) requires further studies.

Since neoplasms are multifactor diseases, it would also be advisable to define the percentage of total variability in neoplasmic occurrence which could be explained by gentic factors. It might be thought then that the application of genetic screening in the primary examinations of persons exposed to carcinogens has not been sufficiently justified thus far. The question is important enough to demand consideration as to how to break this deadlock.

The biological effects of exposure to electromagnetic fields occur in many branches of the national economy. As a matter of fact, these are not the main concern of doctors and hygienists in the case of the chemical industry; but the common use of electricity, electric and electronic appliances in economic activities, renders exposure to non-ionizing electromagnetic radiation possible in certain groups employed in the chemical industry.

CERTAIN ISSUES ON THE EFFECTS OF EXPOSURE TO ELECTROMAGNETIC FIELDS

It should be admitted that the issue of electromagnetic fields has become widely discussed during recent years for two reasons: Firstly, attention was

directed to the possibility of neoplasm development (especially leukemia) in persons exposed to electromagnetic fields, when operating devices which are the source of electromagnetic radiation of various frequencies; and also in people living in the vicinity of industrial power lines (13). Secondly, the question of pregnancy disorders in women operating computer displays has been analysed in various ways.

Considering this question rationally, one may draw a conclusion that the effects of acute, mostly emergency, exposure to electromagnetic fields of high intensity do, beyond any doubt, exist. They are manifested by overt burns of muscle skin or even internal organs (17). Undoubtedly, there also occur functional disorders recalling Parkinson's Syndrome or meningo-encephalic syndrome (22). It may also be expected that an acute exposure will be followed by symptoms related to other known disease entities, even when no burns are observed.

Thus far, neither a specific syndrome of changes influenced by e-m fields nor specific symptoms of functional and biochemical disorders have been characterised in persons exposed to e-m fields of allowable intensities. That means that there are no such symptoms or functional, morphological and biochemical disorders which could be used in early diagnostics of disorders due to exposure to e-m fields of allowable intensity. Various changes may appear as a result of exposure during several or a dozen years but they are also non-specific changes of a nervous nature which are not generally accepted.

In health surveillance (primary and periodical), it is worthwhile to turn special attention to a complete morphological examination of the blood, EEG and ECG. However, these examinations do not indicate specific changes during early exposure to e-m fields, but they are useful in the evaluation of overall health condition during the systematic examination (2, 4, 14, 16, 24, 25). These examinations should facilitate detection if there is an increased incidence of leukemia, disorders in the conduction of stimuli in the myocardium, and changes in the frequency of alpha waves in the brain function.

The question of pregnancy disorders in women operating computer displays was presented, amongst others, by Polish authors at the International Scientific Conference on Work at Monitoring Screens, Stockholm, 1986 (12, 13). However, during the discussion the need was stressed for further epidemiological survey as well as investigations aimed at explaining the role of individual factors defining ergonomic conditions at these working posts. It should be assumed that the evaluation of effects of exposure to electromagnetic fields is of special importance and should be taken into consideration during periodical examinations.

PSYCHOLOGICAL METHOD IN HEALTH SURVEILLANCE

Following the lengthy development of occupational medicine as well as the experience of our own Institute, it should be stated that the "marriage" between occupational medicine and psychology, though already past its prime,

is a very successful one. This is reflected in still wider application of psychological tests in targetted health surveillance. This stems from the fact that occupational exposure to chemical and physical factors occurring in the working environment causes not only somatic changes, but also influences the psychological sphere of workers. Therefore, psychological tests employed in periodical examinations may clarify the picture of adverse effects of negative working conditions. This has become very much in vogue since general agreement was reached on the health definition (5). Apart from that, it is widely known that work-related psychological factors may cause adverse health effects. There are professions and work posts where emotional stress arising from inter-personal conflicts, contradictory expectations regarding one's employment, time pressure, etc. produces psychosomatic diseases (10). Bearing that in mind, psychological tests raise the three following expectations in connection with occupational medicine (Table 4):

Table 4. Psychology in the health care of workers

Work evaluation	Health surveillance	
	primary	periodical
1. Technical and organizational changes	1. Prognosis of work reliability	1. Effect of aging diseases and accidents on worker's reliability
2. Criteria of professional fitness	2. Evaluation of psychic functions, emotional condition and subjective symptoms – "starting condition"	2. Determination of early symptoms of health disorders
3. Time-table and scope of periodical examinations		

a. organizational and technical changes aimed at decreasing the adverse effects of harmful factors experienced by workers following the analysis of working conditions;

b. identification of psychological criteria for professional selection of workers for certain positions, in view of the worker's reliability and his resistance to emotional stresses; and

c. cooperation in defining the time-table and scope of the targetted health surveillance (Table 1).

It may be thought that psychological tests providing information on psychological functions and relatively constant peculiarities of an individual (personality, psychological condition, skills) should be applied both in the primary and periodical examinations.

Psychological tests employed in the primary examinations should serve in:

a. evaluation of a candidate from the viewpoint of his work reliability. Employee errors produce economical losses and adverse health effects. Accidents at work are one of the main causes of disability in populations employed in various branches of the national economy;

b. evaluation of psychological functions, emotional state and subjectively perceived symptoms. This evaluation can be used in assessing the "starting condition" of the central nervous system before exposure to harmful work--related factors has begun. During the successive examinations this "starting condition" may become a reference point facilitating the observation of whether or not any changes have occurred.

Results of psychological tests applied during periodical examinations may serve as a basis for the following important conclusions and opinions:

a. evaluation of the extent of change in an individual's physical condition during the years after an accident or illness, and whether these changes predict diminished reliability of an employee. It might happen that somatic changes do not influence reliability, or that diminished reliability occurs without somatic changes. This means that psychological tests may significantly complement medical examinations;

b. detection of the earliest symptoms indicating adverse health effects in workers exposed to a given harmful work-related factor. The literature provides still more empirical proofs confirming the usefulness of psychological tests (9). Their usefulness depends on the possibility of measuring behavioural disorders before the occurrence of organic disorders, which are very difficult to cure.

In our opinion the advancement of a wide application of psychological tests in targetted health surveillance is sufficient. However, in practice their application faces a number of obstacles. The most important ones are as follows:

1. Lack of an appropriate curricula of under- and post-graduate education which could prepare psychologists to perform such tasks. In the course of studies, students of psychology may specialise in clinical psychology, labour psychology, educational psychology and so forth. A graduate involved in problems of occupational medicine has to specialise at the same time in labour and clinical psychology. Such a combination of interests is relatively rare among psychologists.

2. Insufficient investigation methods, whose accuracy and sensitivity have been tested in the conditions peculiar to a given country. In Poland, for example, there is no highly qualified centre which could elaborate new methods or adapt foreign methods and promote them among psychologists.

COMPLEX EXPOSURE AND PERIODICAL EXAMINATIONS IN WORKERS OF ADVANCED AGE

Two problems remain to be discussed in the last part of this treatise; complex exposure to toxic substances; and health conditions and work ability

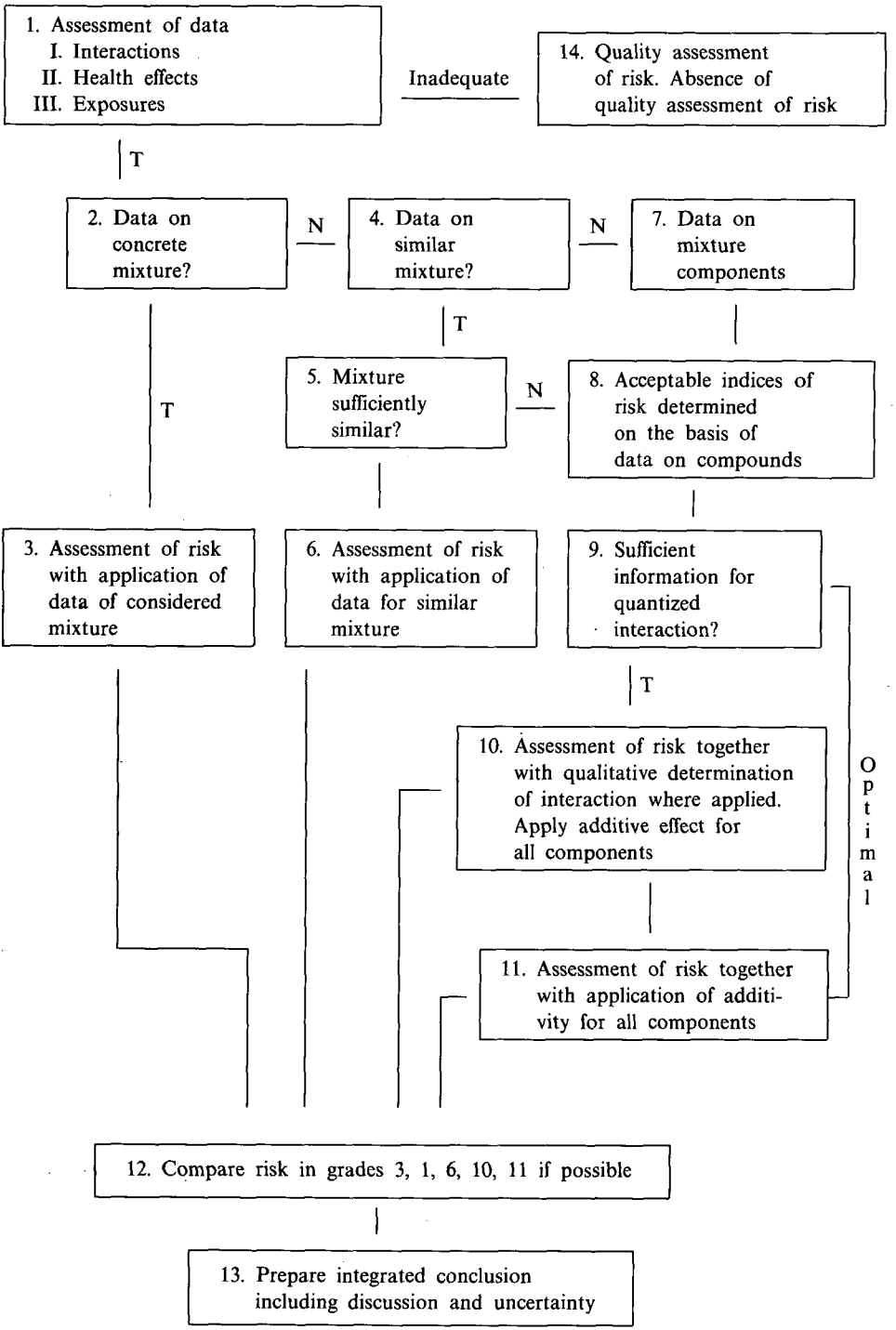

Fig. 1. Gradual graph of risk assessment. It should be noted that the conduct of all the three assessments could be required, if possible, (using data on the mixture, similar mixture or components) in order to use, in full, the available data.

in persons of advanced age. Bearing in mind the range of the problems, which of themselves could comprise a separate paper, their presentation must be rather brief.

Observing the progress during evaluation of a complex exposure to toxic substances and most of its effects, there is the impression that because of known reasons (the immeasurable number of toxic substance mixtures, and gaps in our knowledge about the mechanisms effecting each individual substance), it is still difficult to formulate conclusive recommendations on the application of screening methods in targetted health surveillance, which could facilitate early diagnosis of intoxication as well as individual evaluation of the susceptibility of exposed persons, except for just a few examples (exposure to asbestos, smoking, some mixtures of solvents, etc.).

As far as complex exposure is concerned, the philosophy, system of ideas and collection of data on the interaction of complex exposure factors (including molecular changes), have been much more extensively developed than prophylactic methods. In the existing information on this subject, e.g. a report by the Scientific Group on Methodologies for the Safety Evaluation of Chemicals (SGMSEC) published in 1987 (21) proposes methodology which could be rather used by researchers and scientific centres than by occupational doctors responsible for practical preventive activities. As to the evaluation itself of exposure to chemical substance mixtures, recommendations worked out three years ago by the Environmental Protection Agency (19) comprise the basis for evaluation of those mixtures; together with other procedures which are dependent upon the availability of data, lack of data or comparability of data on similar mixtures (Fig. 1).

It should be admitted that the proposed procedure is logical. But it may be supposed that the most common situation will involve, at least, some compound mixture for which data will not be available; consequently creating the necessity of applying a selected model of evaluation of an additive effect, based most often on data obtained via acute exposure. This does not mean, of course, that complex procedures should not be taken into consideration in targetted health surveillance; however, it will often require cooperation with relevant scientific centers.

It is generally known that the state of health, both of the general population and groups of working people, deteriorates with age. The legislation on health protection of the working population in individual countries regulates employment of women and juveniles in conditions of chemical exposure. But the existing regulations do not refer to workers over 40 years of age. It is well known that the aging process (even within physiological limits) may influence absorption of toxic substances, kinetics of their metabolism and sensitivity of an organism to the effect of toxins. Even in the case of such a common industrial substance as carbon disulphide, there are no age-related data on interaction of lipid disturbances. Since the frequency of chronic diseases in the population (such as hypertension and other disorders of the circulatory system, diseases of kinetic organs, the digestive system and the respiratory system) increases with age, one may easily draw the conclusion that

it is not possible to refer to the same health criteria – and similar scope and frequency of periodical examinations – in evaluating work ability, and primary health examinations, of persons commencing their work at a young age. Apart from that, it is generally known that chronic intoxications and other occupational diseases usually emerge after 49 years of age, and they display various specificities of symptoms toward the exposure factor.

It is difficult to present all the details concerning this subject; however, its importance should not be underestimated. Its significance depends on the fact that persons over 40 years of age are very highly valued workers because of their experience; additionally it is obvious that their industrial productive life span is of great social and economical significance. It should be then taken for granted that the principles of health protection of people in advanced age, who are professionally active, require more systematic procedures in regard to health surveillance. As a side-note to this problem, another question of great importance should be raised due to preventive measures applied in Poland in the past: namely people over 50 years of age were directed to work exposed to aromatic amines. It was thought that the incidence of urinary bladder neoplasm, observable after a 20 year latency, would decrease as a result of shortening the exposure period to three years, after which workers were retired. So far, the results of this practice have not been analysed sufficiently; but it appears from the findings of Seidman and his colleagues published in 1979 (22) that increased mortality due to lung cancer was observed among persons of the so called "cancer age" (i.e. over 40) exposed for the first time to high concentrations of asbestos, shortly after they began working under this exposure. Results of investigations carried out by these authors suggest a considerable shortening of neoplasm latency, along with increased incidence. In the observed group of persons exposed to asbestos in Poland, the suggested relationship was confirmed. Despite doubts about whether observations other than those regarding asbestos carcinogens should be considered, these problems deserve some attention.

As it appears from a brief discussion of some selected questions related to the strategy of health surveillance, as well as to potential possibilities of the application of modern methods in preventive examinations, the issue is complex and very difficult at the same time.

Literature is full of publications containing completely new, updated and significant proposals which could be used in health surveillance. In spite of that, the distance between science and practice is wide, and hedged in not only with obstacles of a methodological nature, but also with doubts which sometimes even hinder the interpretation of results. Besides the overt absence of verification of proposed methods on the basis of well-planned epidemiological surveys, one may suspect that the main reason for delays in practical application of results is lack of cooperation between scientists and doctors who perform prophylactic examinations, along with a lack of motivation on both sides to implement their own results or apply newly acquired possibilities. At the risk of sounding like an accusation, it should be stressed that, in the end, financing and development of research depend upon effects attained in practice.

There is a sentiment that this phenomenon refers not only to targetted health surveillance but also to occupational medicine as a whole.

Returning back to the statement, presented in the beginning – that there is a considerable gap between ideology, health care, scientific progress and practice it seems that insufficient financial means cannot be blamed as the underlying reason. It may prove necessary to select not only methods, but the subjects of preventive activities, based entirely upon cost-benefit assessment. As to the selection of methods of detection according to cost-effectivity, we favour the arguments presented by Alfredo Morabia et al. in his article published in the American Journal of Industrial Medicine (16) on the trends of medical examinations of chemical industry workers with evident risk of fluorosis. This is undoubtedly a good example of a decisive analysis joined with an analysis of sensitivity, undertaken to evaluate the usefulness of a screening program for various levels of anticipated incidence of fluorosis, as compared to the method of individual diagnosis of the disease. The evaluation presented therein concerning the profitability of screening (being dependent upon the number of years of exposure to fluorides, based on the function of lost working years because of fluorosis) is also convincing. A good example of this is, however, determined by circumstances which are rather rare, namely:

a. high specificity of fluorosis symptoms in regard to the exposure factor;

b. relatively high specificity (80%) and sensitivity of test (60%), even when compared with other methods applied in individual diagnostics;

c. easy accessibility and low cost of the fluorides determinant for urine; and

d. clear cut principles of screening the interpretation of the results.

It should be admitted that such an unusual coincidence of circumstances does not often happen according to the given example, which supports both the application of biological screening in periodical examinations, as well as a cost-benefit analysis based on the comparison of financial losses arising from paid disability pensions and compensations. The latter question, namely the cost-benefit analysis related to the screening application, and finally to preventive activities is also not always a pertinent issue, especially in cases when distant effects of exposure appear after the productive age and cause shortening of the life-span. Because of these reasons, it should be stated that health agencies involved in prevention are also morally responsible for the implementation of scientific progress in the targetted health sector, and for filling in the gap between the research results and their application in health care practice.

In this article, an attempt has been made to discuss only some selected aspects of the complex problem of prophylactic examinations. It seemed necessary to focus on the strategy, the trends and goals of health surveillance, the impact of economics, conditions of their prospective implementation, and training of personnel. It was also necessary to consider behavioral changes, as well as complex exposure to factors present in the working and municipal environments.

During this discussion, the problems found to be most important refer to

individual, genetically determined susceptibility to occupational noxiousness; and the necessity of applying screening tests to detect congenital, enzymatic and metabolic defects. The distant effects of exposure to toxic factors infuencing reproductive disorders, defects and ill health in future generations, and development of cancerous diseases, are also relevant. Health problems in advanced age were also discussed, with special emphasis on the observation that in this group of persons, symptoms are produced by long-lasting occupational exposure.

We are of the opinion that all the discussed problems are of great significance to further development of preventive medicine. Other related problems should also be added, which could not be thoroughly presented here, or only briefly mentioned: including advancement of methods employed in evaluation of working conditions; biological monitoring as an integral part of a preventive strategy; and some questions of evaluation of preventive activities.

The problems of personnel training for occupational health services, as well as encouraging a healthy life style in workers exposed to noxious factors in working conditions, were also omitted from this article.

We think that it is necessary to discuss such questions (related to the application of new methods in health surveillance, whose results could be interpreted and applied in practice), even if their application is limited by financial or other obstacles. What seems impossible now may become available in the near future, including not only individual aspects but also all issues concerning targetted surveillance; or even occupational medicine as a whole.

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