

## CURRENT OCCUPATIONAL HEALTH PROBLEMS IN THE CHEMICAL INDUSTRY

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### ABSTRACT

Although there has been a spectacular expansion in the chemical industries all over the world in the last few decades and although the benefits of technical progress cannot be denied, it is unfortunate that this may be accompanied by some unhappy circumstances and serious threats to human life and the environment. There is no doubt that the accidents which have occurred in recent years initiated the "Toxicological Wave".

Knowing what happens, how it happens and where it happens in the chemical industry throughout the world is of paramount importance to the industrial doctor. However, this involves problems, as nowadays we are confronted with so much information not only from scientific sources, but also from the lay press and the mass media. The doctor in the chemical industry needs to know what is going on in various international institutions and in various countries. Some of the more important institutions dealt with are: UNO, WHO, ILO, ISSA, IARC, COME, OECD, CEFIC and ECETOC. With regard to the countries it is important to know which problems are under discussion and which standards and regulations have been enforced or are in preparation with the aim to combat these problems.

Apart from ensuring that various laws, regulations, recommendations, etc., are being observed in his company, the industrial doctor will probably be involved, to a greater or lesser extent, in the following tasks: preplacement assessment, periodic and special medical assessment, documentation-data collection, information and instruction, preparation of a disaster plan, interpretation of toxicological data and risk/benefit evaluation.

Although highly toxic substances are used in the chemical industry, the dangers are sometimes exaggerated. It should be appreciated that workers have a right to be informed about the specific hazards of the chemicals that they are handling.

Obviously laws, regulations and recommendations are necessary, but there seems to be a serious risk of over-regulation. Personal responsibility is more effective than regulations. The standards set should be "realistically achievable". In view of the number of regulations to be satisfied the chemical industry must emphasize the high price that the public will have to pay for safety and the public must realize that it will have to accept some degree of risk.

In addition, the increasing number of medical examinations required raises the question whether a point will be reached at which it is more economical and reasonable to support employers by monitoring the exact exposure to toxic substances than by carrying out the examinations.

One of the problems in this connection is a shortage of properly trained personnel in both occupational medicine and industrial hygiene, and governments and institutions should make greater efforts in this direction.

Finally, emphasis should be placed on the successful international efforts which industrial doctors have made in recent years in collaboration with chemists, toxicologists, biologists and safety experts, supported by management and employee representatives.

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It would be an impossible task to present in this paper all the responsibilities in health care of an industry which provides more than 10 million jobs, produces a variety of roughly 2 million products and contributes more than 400 billion dollars to world trade<sup>5</sup>. My intention is, therefore, after taking stock of some current problems in various institutions and countries, to outline the major challenges facing a medical doctor in the chemical industry. The problems pertaining to occupational cancer, asbestos and heavy metals have been omitted as these will be dealt with by other experts.

In preparing my paper I have contacted experts familiar with the problems in their countries, and I should like to take this opportunity to say a very warm "thank you" to them; you will understand that it is not possible for me to mention them all individually.

Current problems in the chemical industry have always featured largely on the agenda of Medichem (**Medical Doctor in the Chemical Industry**) – a sub-committee of the Permanent Commission – because it was and is our aim to enhance on a scientific basis the understanding of problems in occupational medicine in the chemical industry worldwide. Thus at previous Medichem Congresses we dealt with the following topics:

- Ludwigshafen (1972): "Preventive measures in the chemical industry",
- Milan (1974): "Chromosome aberrations due to chemical substances" and "The VC problem",
- Brighton (1975): "Methods of investigation into occupational cancer",
- Haifa (1976): "Seveso",
- San Francisco (1977): "Epidemiological risk studies".

#### CAUSES AND CONSEQUENCES OF THE "TOXICOLOGICAL WAVE"

Although there has been a spectacular expansion in the chemical industries all over the world in the last few decades and although the benefits of technical progress cannot be denied, it is unfortunate that this may be accompanied by some unhappy circumstances and serious threats to human life and the environment. There is no doubt that the accidents which have occurred in recent years, initiated the "Toxicological Wave". These have been: lung cancer from bis-chloromethylether, vinyl chloride haemangiosarcomas, asbestos mesotheliomas, dioxine, e.g. in Seveso, polychlorinated and polybrominated biphenyl, e.g. in USA and Japan, dibromochloropropane, kepone and leptophos, Minamata (mercury) and Itai-Itai (cadmium) in Japan, and toxic hepatitis in Taiwan.

In addition to the accidents there have also been contributory factors to the "Toxicological Wave":

- the restrictive behaviour of some employers, institutions and industrial doctors;
- increasing worldwide consciousness of the environment;
- the public's loss of confidence in scientific experts;
- improved techniques in clinical testing and biological monitoring: measurements in parts per billion, a combination of gas-liquid chromatography and mass spectrometry, laser probe technology and X-ray emission spectrometry;
- the campaign, sometimes emotional, by the mass media to enlighten the public on all accidents and cases of poisoning.

Some press releases even talk about an age of cancer and hold the environment and the chemical industry primarily responsible for the increase in malignant tumours. Environmental cancer is, however, primarily a "life-style" problem and not a result of industrialization alone. According to Higginson from IARC<sup>7</sup> and Wynder and Gori<sup>17</sup> from NCI, factors such as smoking, drinking and improper diet are the major causes of environmental cancer, and food additives, air and water pollution and the chemicals at the workplace contribute relatively little to the problem. The American Industrial Health Council (AIHC) claims that using age-adjusted figures from the National Cancer Institute (NCI) shows that the only increase in cancer seems to be that due to cigarette smoking<sup>4</sup>.

#### ACTIVITIES OF VARIOUS INTERNATIONAL INSTITUTIONS AND COUNTRIES IN COMBATING OCCUPATIONAL HEALTH PROBLEMS IN THE CHEMICAL INDUSTRY

Knowing what happens, how it happens and where it happens in the chemical industry throughout the world is of paramount importance to the industrial doctor. However, this involves problems, as nowadays we are confronted with so much information not only from scientific sources, but also from the lay press and the mass media. The doctor in the chemical industry needs to know what is going on in the various international institutions and in the various countries.

The activities of some of the more important international institutions will now be dealt with:

UNO has been operating a central data bank since 1976;

WHO is engaged in: early detection of health impairment, health-related environmental monitoring, establishing methods for periodic medical examinations, prevention of occupational diseases and fixing exposure limits;

ILO monitors health hazards, disseminates information on these hazards and sets international standards for control of these hazards.

The ILO International Occupational Safety and Health Information Centre (CIS) would issue an annual list of limits for harmful substances as an ILO recommendation for the different countries of the world. ILO is also planning to establish a Health Hazard Alert System which will provide an exchange of information on all substances suspected of having toxic or carcinogenic properties. Doctors in the chemical industry should also be reminded of the ILO

Encyclopaedia on Occupational Health and Safety which deals with every aspect of occupational health in great detail.

In view of the large number of special terms, for example for exposure limits: maximum allowable concentration (MAC), threshold limit value (TLV), permissible level (PL), limit value (LV), average limit value (ALV), permissible limit (PL), time-weighted average (TWA), industrial hygiene standards (IHS), maximum permissible concentrations (MPC) etc. and on account of the different senses in which the terms are used and understood, special mention should be made of the endeavours of WHO and ILO to establish a uniform list of exposure limits<sup>1</sup>.

There are many other institutions of which the doctor in the chemical industry should be aware.

Further international institutions are:

- ISSA – International Social Security Association – has 300 members in 97 countries,
- IARC – International Agency for Research on Cancer – identifies carcinogenic factors,
- Directory of On-Going Research in Cancer Epidemiology – issues 908 on-going research projects in cancer,
- COME – Committee on Mutagenesis Emergency – undertakes immediate investigation of disasters,
- World Federation of Associations of Clinical Toxicology Centres and Poison Control Centres,
- AST – Advisory Subgroup in Toxicology of European Medical Research Council – aim to link chemical research with practical experience.

#### **OECD – Organization for Economic Cooperation and Development**

OECD has established six Expert Groups to work towards the harmonization of test methods. They are:

- Physical Chemistry Group (FRG),
- Eco-toxicology Group (Netherlands),
- Persistence Group (Japan and FRG),
- Long-term Toxicology Group (United States),
- Short-term Toxicology Group (United Kingdom), and
- Step Systems Group (Sweden).

The intention of the final group, namely the Step Systems Group, is to examine the differences between all the existing step-sequence testing systems from the United States, Japan, the United Kingdom, France, Canada, the European Community and other countries.

#### **EC – European Community**

As in the United States, the EC has made great steps forward in recent years in establishing the most effective protection measures. EC Plan of Action for

Safety and Health Protection at the Working Place of 15<sup>th</sup> December 1977 includes:

- Determining causes of accidents
- Fixing maximum exposure limits
- Registration of carcinogenic substances
- Analysis of medical data
- Development of detection tests
- Surveillance of toxic substances in the chemical industry.

Environmental chemical legislation consists of: central register of toxic substances, uniform test and registration procedures and uniform assessment criteria.

Environmental chemical legislation already exists in a number of countries, as for example France, Norway, Sweden, USA and Japan. Test procedures and assessment criteria for chemicals which are a danger to the environment are being prepared by the EC as well.

In the EC Working Group in Luxembourg "Occupational Hygiene in the Chemical Industry", representatives of industry, institutions and universities discuss all topical subjects in industrial medicine, and the EC Working Section in Brussels has drawn up, as an initial step, a European Uniform List of Occupational Diseases<sup>8</sup>.

The chemical industry's principal voice in Brussels is CEFIC, the European Council of Chemical Manufacturers' Federations. It was established six years ago to represent the chemical industry's manufacturers' federations of the nine EC countries plus those of Austria, Norway, Spain, Sweden, Finland, Switzerland and Portugal. More than 40 groups within CEFIC deal with eco-toxicological problems, specifically related to the production and use of certain classes of chemicals.

ECETOC - European Chemical Industry Ecology and Toxicology Centre - as a strictly scientific organization, is similar to CIIT (Chemical Industry Institute of Toxicology) in the USA. It aims to coordinate the efforts of its more than 30 members and, by cooperating with existing organizations, to expand knowledge about the toxicological and ecological effects of chemicals.

Regarding occupational health problems in the chemical industry, the characteristic points in some countries should be mentioned. Number of harmful substances registered in some countries are shown in Table 1.

#### **United States**

A start will be made with the United States because this is the country where one is particularly aware of the "Toxicological Wave". Daily press releases, both scientific and non-scientific, flood our desks concerning legislation, for example, the Toxic Substances Control Act (TSCA), and the Delaney Clause, concerning institutions, for example, the National Institute for Occupational Safety and Health (NIOSH), the Occupational Safety and Health Administration (OSHA), the National Cancer Institute (NCI), the Chemical Industry Institute of

TABLE 1  
Number of harmful substances.

Country	Year of publication	Number of harmful substances		
		Total	Toxic substances	Fibrogenic dusts
USSR	1976	828	703	125
USA	1976	665	617	48
Yugoslavia	1976	541	519	22
Switzerland	1976	510	469	41
Finland	1976	464	429	35
Japan	1975	412	407	5
Rumania	1975	397	375	22
FRG	1976	360	345	15
Poland	1976	212	204	8
Italy	1975	206	176	30
GDR	1974	182	169	13
Sweden	1975	118	110	8
Hungary	1974	112	105	7

Toxicology (CIIT), and the American Industrial Health Council (AIHC), and concerning subjects such as asbestos, vinyl chloride, acrylonitrile, styrene, hair dyes, fly ash (cadmium, cobalt and nickel), benzene, chloromethyl ethers, dibromochloropropane, ethylene oxide and bromide, PCB, PBB, etc.

Probably the largest question facing both the Environmental Protection Agency (EPA) and the chemical industry now under TSCA is how the premarket notification system will be implemented.

#### The USSR

The great activity in the USSR is reflected in approximately 1 000 legislative documents in the form of standards, rules, regulations, etc., on occupational safety and health and industrial hygiene. The international legislative labour acts of the ILO Convention were specifically reflected and defined in the Soviet Labour Codes. About 600 million investigations are carried out annually by 80 000 medical doctors<sup>12</sup>. As regards the specific standards for harmful substances the majority are to be found in the USSR and the States<sup>10</sup>.

#### India

In India and other developing countries the basic problem in occupational health in the chemical industry is unawareness, on the part of the employers, workers, trade unions and even society at large, of the extent of damage to health that can result from toxic chemicals. In India, for example, as in many other countries, there is no legislation requiring an employer to provide occupational health services.

#### Japan

In Japan, a series of incidents, for example, the Minamata (mercury) and PCB accidents and the Itai-Itai (cadmium) disease, have led to stricter legislation

regarding health protection measures at the working place and for the environment.

#### Italy

In Italy, the question of health and environmental protection has become a concern for industry government experts and union representatives, not only as a result of Seveso.

Altogether 705 papers (91 scientific and 614 press articles) were discussed during a period of 18 months after the accident (based on personal information from Dr Reggiani of Hoffman La Roche). Summary of medical and other examinations is shown in Table 2.

TABLE 2  
Seveso accident.

Medical examinations	
Paediatrics	11 577
Internal medicine	23 012
Obstetrics and gynaecology	17 796
Dermatology	18 201
In addition 3 checks on school children	
Neurology	1 190
Occupational medicine	5 618
Laboratory parameters	280 506
Deaths of farm and domestic animals	2 178
Animals slaughtered in emergency	63 374
Number of doctors consulted	124
Scientific institutes	38

And what is the outcome of Seveso? We can be thankful that up to 1st March 1978 there were no mortalities, no hospitalized treatment cases, no miscarriages, no deformities, no abnormal developments in any children since the accident, no damage to immune capability of children who suffered chloracne and no chromosome changes in the population examined.

#### The United Kingdom

Following an inquiry in the United Kingdom into safety and health at work, there now exists a body in the form of the Health and Safety Commission (HSC), advised by the Advisory Committee on Toxic Substances (ACTS), to which notification of new substances has to be made. As in other highly developed countries, such as, Belgium, German Democratic Republic, France, the Netherlands, Sweden, Switzerland, etc., highly toxic substances, the carcinogens, and establishing uniform methods are constantly being discussed and investigated.

#### Israel

In Israel, particular emphasis is also being placed on earlier and closer supervision of working population, detection of hypersusceptible individuals at the preplacement level and recommendations to enforce prompt publication and notification of toxic substances to an international centre.

**The Federal Republic of Germany**

In the Federal Republic of Germany, mention should be made of the Law on Occupational Safety (ASIG)<sup>6</sup>, Ordinance on Dangerous Working Materials<sup>16</sup>, Workplace Ordinance<sup>2</sup>, Draft on Environmental Legislation (still under discussion), Programme of the Chemical Employers' Association (36 principles for precautionary examinations)<sup>3</sup>, and activities of the Association of the Chemical Industry (VCI)<sup>14</sup>.

**Yugoslavia**

In Yugoslavia the chemical industry, including the oil industry, with its 246 plants, employing 121 000 people, is faced with the toxicological problems which concern:

- solvents: carbon disulphide, methanol, trichlorethylene, carbon tetrachloride, benzene, toluene, xylene and ketones
- additives: sodium nitrite
- polymers: polyvinyl chloride (3 cases of angiosarcoma), polyethylene and epoxy resins
- pesticides
- halogenated hydrocarbons.

**CURRENT TASKS OF THE MEDICAL DOCTOR IN THE CHEMICAL INDUSTRY**

Apart from ensuring that various laws, regulations, recommendations, etc., are being observed in his company, the industrial doctor will probably be involved, to a greater or lesser extent, in the following tasks.

**Preplacement assessment**

We are sometimes criticized that we only select people fit for the Olympic Games and this at a time of high unemployment in many countries. It is therefore essential to point out that the industrial doctor should only act in an advisory capacity and that good communications should be established between medical, management and union representatives.

**Periodic and special medical assessments**

Everybody will agree that in this day and age our workers are examined more regularly than ever before and that our examinations have become much more extensive. In particular, far more epidemiological studies are being carried out to help us monitor occupational mortality and morbidity, but it would be better to initiate more voluntary epidemiological studies before these become necessary.

**Documentation - data collection**

It has become obvious that documentation must be maintained for at least 25 years and highly toxic substances, especially the carcinogens, should be monitored and registered. Recommendations for such programmes already exist in some countries and in the FRG the Employers' Association of the Chemical Industry which is equally composed of employers and employees, has already



started such a project<sup>11</sup>. Data gathering is not a mere medical exercise primarily based on confidentiality but requires the cooperation on a national and international basis of various functions in the personnel, computer, legal, technical and financial fields. Its ultimate aim is the development of a uniform worldwide documentation system.

### Information and instruction

Information and instruction are increasingly becoming a task of the medical doctor in the chemical industry. How necessary it is to instruct employees was demonstrated by the three most-publicized industrial tragedies involving the Kepone, Leptophos and dibromochloropropane problems in the States, all of which were brought to the attention of the government by workers.

### Disaster plan

Accidents in recent years have underlined the necessity for disaster plans<sup>15</sup>. They should be tested at intervals and should be set up for all severely toxic substances, for example BASF's Chlorine Alarm Plan (Fig. 1). In another plan all the hospitals in the neighbourhood of BASF have been listed (Fig. 2).

### Interpretation of toxicological data

Close cooperation is needed, now more than ever, between toxicologists and industrial doctors. We are aware of the toxicological data but we must take care in extrapolating them. Dr Robert Murray, Secretary General of the Permanent

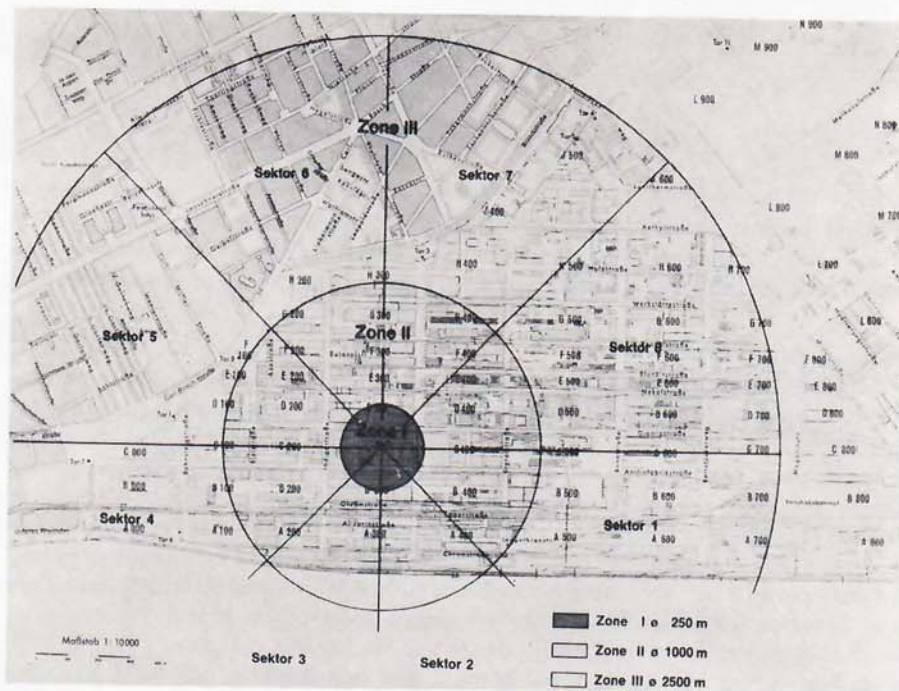


FIG. 1 - BASF's chlorine disaster plan.

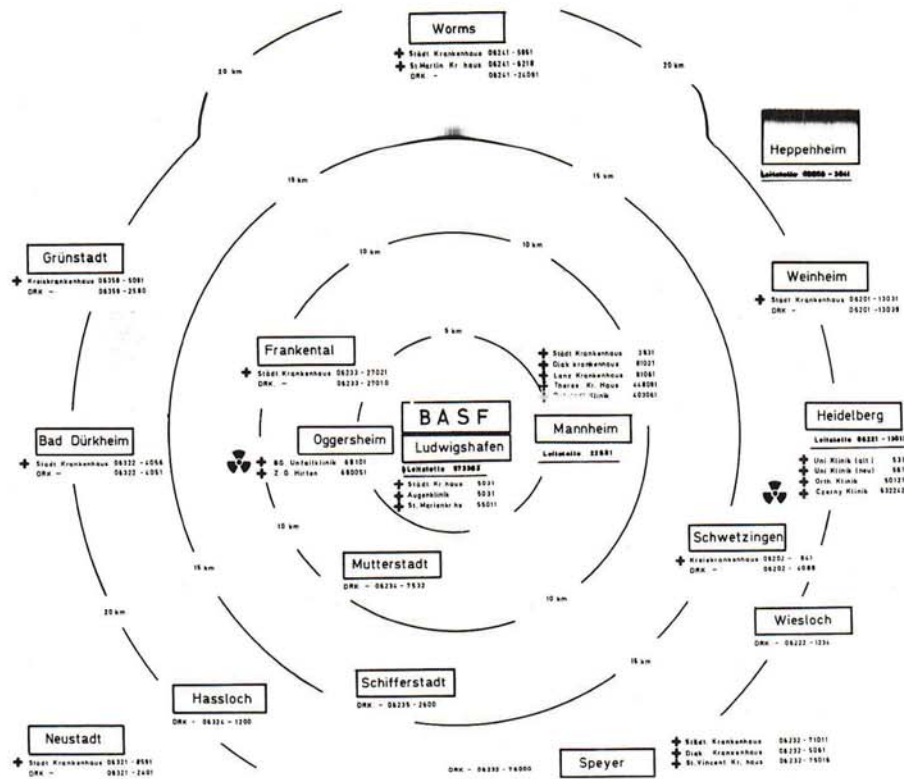


FIG. 2 – Hospitals in the vicinity of BASF.

Commission, stated during our 5th Medicchem Congress in San Francisco: "The introduction of bacterial mutagen tests such as the Ames test introduces a new dimension to our anticipation but also a new area of scientific doubt and uncertainty."<sup>9</sup>

#### Risk/benefit evaluation

We doctors in the chemical industry not only have a duty to do everything for the employees' health and protection but we are also responsible for ensuring that they are not alarmed by unsophisticated messages and are not pushed into chemophobia. As a leading chemical company executive recently explained: "Its symptoms are an almost irrational fear of the products of chemistry. The popular prescription for the 'cure' is another strong dose of regulation."<sup>13</sup> Should we medical doctors as advisors be concerned about risk/benefit evaluation? Surely the answer must be "yes." It is essential that a balance should be struck, based on what is reasonable in terms of meeting society's expectations for both minimizing health hazards and maximizing productivity. We should therefore provide help in differentiating between acceptable risks and unacceptable risks and consider carefully which substances should be banned.

## CONCLUSIONS

### Industry

All over the world the chemical industry seeks institutionalized cooperation, based on expertise and experience, with all the organs responsible for the protection of health. Here the industrial doctor can play an important role. Cooperation, however, requires a constant dialogue between the legislator, the executive and the relevant experts starting with the design of a chemical plant up to production and implementation of legal provisions. Hearings alone are not enough.

The chemical industry is no longer associated with the evil-smelling factories of the last century, and uneasiness about the dangers of the chemical industry is not always justified. Occasional incidents, such as Seveso, Michigan and Flixborough, confirm certain prejudices. It is true that highly toxic substances are used in the chemical industry. However, measures such as the constant technical checking of toxic amounts of products, employment of optimum safety measures, toxicological and ecological testing of products, informing and educating the employees and a national and international exchange of information, have demonstrated, as in the case of VC/PVC, that these problems can be solved successfully.

### Regulations

National laws, ordinances, for example TSCA, EC guidelines, ILO recommendations, accident prevention regulations issued by the Employers' Association (e.g. Berufsgenossenschaft in the FRG) are necessary. However, not every industrial activity should be regulated by laws and ordinances. Personal responsibility is more effective than regulations.

Nevertheless, there now seems to be a serious risk of overregulation, which is causing a considerable wastage of valuable professional resources in terms of countering unreasonable proposed regulations. Regulations should be responsive to improving health and safety and should be on a "performance" basis as opposed to a specific design basis. Criticism has been voiced of the work of some of the institutions. For example, it is stated in the *Journal of Occupational Medicine*, November 1977, Vol. 19, No. 11, p. 724: "Let us put emphasis into the areas where the need is - let us spend our money where we should and must, to prevent death and illness and let us set standards for this purpose which are realistically achievable and will assure a healthy and lasting working environment for both employee and employer".

### Policy

It is important that the chemical industry achieves credibility in recognizing that it has had serious occupational health problems, not necessarily as a result of negligence, but certainly as a result of increasing technology and increasing ability to evaluate and diagnose occupational health problems. Therefore, these problems will continue to "be discovered". Management and occupational health professionals in these fields must deal with the question of effective and efficient delivery of these expensive services.

What the industry has to emphasize is the high price that the public will have to pay for safety. People will have to realize that the price for absolute safety – or rather near absolute, is too high, and as with flying, driving and smoking, it will have to accept some degree of risk.

#### **Labour**

The adversary roles, in some countries, of management and labour in problems related with health protection should be diminished. One way this can occur is for labour to develop a stronger, technical competency in the professions of occupational health and industrial hygiene. In the FRG for instance union representatives are working with the professionals in the Employers' Association of the Chemical Industry together. The chemical industry should appreciate that workers have a right to be informed about the specific hazards of the chemicals they are handling.

#### **Challenges**

Much work has already been done on reducing the risks to health impairment in the chemical industry, but we still have tasks ahead of us.

In view of the increasing number of examinations which have to be carried out, the question arises whether a point will be reached at which it is more economical and reasonable to support the employer by monitoring the exact exposure to toxic substances rather than by medical examinations, or do we have to continue carrying out investigations in the future even in the ppb range? Can we solve these toxicological and occupational medical problems merely with data from animal tests? Can we justify using hundreds of thousands of animals in order to solve these problems? As Professor Irving Selikoff (USA) and Dr Leo Djerassi (Israel) have stated, more attention should be paid: to detoxication problems and the development of analytical methods for toxic products and their metabolism; to sensitization, and adaption to harmful substances; to interference of habits (alcohol) or continuous treatment with drugs; to changes in behaviour; to special problems relating to women at the workplace, such as contamination of breast milk, and transplacental effects in terms of foetotoxicity, mutagenicity and teratogenicity.

In view of the shortage of properly trained personnel in both occupational medicine and industrial hygiene, industry, governments and institutions should make greater efforts to come to grip with these problems.

In conclusion, emphasis should be placed on the successful international efforts which industrial doctors have made in recent years in collaboration with chemists, toxicologists, biologists and safety experts – supported by management and employee representatives – even though not all chemical substances have been examined for their toxic, mutagenic, teratogenic or carcinogenic effects, and we may remain in the crossfire of unjustified attacks. If all the technical safety measures are strictly observed and every precaution is taken after the employees have been informed, chemical processes can be operated without risks.

If you ask me what I consider to be the most important factor in our efforts to solve "Current Occupational Health Problems in the Chemical Industry", it is

the encouraging fact of our successful international cooperation in friendly solidarity in the comprehensive field of health protection in the chemical industry. Our generation has been faced with enormous new challenges; we have started to cooperate over the boundaries more than any other medical doctors in the field of occupational health have done in the past, and we have learnt a lot from each other. Our meeting at the 19th International Congress on Occupational Health in Dubrovnik was a further very important contribution to this.

Only if we can continue to tackle the manifold tasks still before us on a broad international basis, while engaging the political forces in our countries, shall we achieve further success in maintaining the health of those in our care, which is what we are all striving for. Each of us is called upon to play his part.

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