INTER-RELATION BETWEEN ENVIRONMENTAL MONITORING DATA, HUMAN EXPOSURE AND HEALTH EFFECTS

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Abstract. To determine whether a population has been affected by a chemical, evidence of exposure must be established. The mere presence of a chemical in the surroundings of a population may not, in all instances, result in actual exposure. Not all such exposures will cause health effects; nor is it always possible to establish that illness has or will result from exposure to chemicals. The inability to establish health effects in humans cannot a priori be translated to mean that a specific chemical is harmless. On the other hand, it must be determined whether health studies would be fruitful. If exposure was so minimal that no health effects are expected, then no health studies should be conducted.

1. Introduction

This paper addresses three different entities: the presence of chemicals in the human environment, the possibility that chemicals from the environment may actually get absorbed into the human body, and the possibility that once chemicals have been absorbed, health effects may result. However, this sequence of events does not necessarily always take place. Even if it takes place, it is difficult and at times impossible to establish such a chain of events. It must also be recognized that we all are continuously exposed to naturally-occurring as well as man-made chemicals of all sorts. Many chemicals, namely nutrients, are actually beneficial. There are some that are generally inconsequential, and then there are others which may have deleterious effects if humans get exposed to them. Whether or not an effect occurs in a given individual depends on many factors; among them, the degree of exposure. I will address these different areas, that is, exposure, susceptibility, and health effects. Unfortunately, I will only be able to point out problems without having positive solutions or constructive suggestions.

2. Exposure

2.1. FACTORS INFLUENCING EXPOSURE

Human exposure to chemicals may take place by gastrointestinal absorption through ingestion, by the respiratory tract through inhalation, or by dermal absorption through contamination of the skin. How easily a chemical can be absorbed depends on its solubility, its disassociation constant, and its distribution coefficient. Factors specifically affecting absorption by the respiratory tract are particle size and vapor pressure.
Unfortunately, this type of information is often not available. For instance, the distribution coefficient may vary widely and the solubility is known for relatively few vapors and gases in blood at room temperature. Similarly, the proportion of a given chemical which will be absorbed through the human skin is usually not known. Some estimates can be made from animal studies for some of this information. However, there are no good animal models for studies of human skin absorption. The skin of the guinea pig, pig, and monkey resembles human skin most closely (Wester and Maibach, 1977), but most dermal absorption studies have been done in rats. The ease with which chemicals may penetrate the skin varies in different areas of the body. Absorption is greatest for the skin of the scrotum and least for the palms of the hands and the soles of the feet. Skin absorption in premature infants is much more efficient than in older children (Nachman and Esterly, 1971). For most chemicals, the actual dose of the amount applied to the skin that is absorbed is not known. Maibach et al. (1971) conducted a series of studies with pesticides and determined that about 10% or less of the material applied to the skin was absorbed.

2.2. TYPES OF EXPOSURE IN HUMANS

Except for occupational exposure where chemical concentrations in air and on surfaces of the work area were high (Cannon et al., 1978; Folland et al., 1978), the majority of episodes of acute poisoning in human populations have resulted from the ingestion of toxic substances (Diggory et al., 1977; Carter, 1976; Cam, 1963; Hayabuchi et al., 1979; Takeuchi, 1962).

Because of the sudden onset of illness in increased numbers of people, such acute episodes are usually recognized and their cause is identified. Because of the emergency nature of such outbreaks, preventive measures are often instituted without adequate and well designed scientific studies which could give information on toxic dosage levels, concentrations of chemicals in blood and tissues, and their relation to abnormal clinical chemistry tests and morphological changes in tissues. Chronic health effects from continuous exposure to chemicals which cause deleterious effects are much more difficult to detect and so are delayed effects of acute short-term exposure. Basically, our knowledge in this area is limited to our experience with occupational exposure, cigarette smoking, the long-term effects of estrogenic hormones, and exposure to heavy metals. Thus, it is presently not clear whether different routes of exposure may be of more or less importance for chronic health effects.

2.3. IMPORTANCE OF THE ROUTE OF INTAKE

Absorption by inhalation would deliver the chemicals in a very efficient way to the body since the human lungs have a surface area of about 55 m² and of a given concentration of a chemical in air, much more would be taken up by the body than when the material was at the same concentration in food. However in order for the lungs to absorb the chemical, it must be volatile or in small enough particles that it can be inhaled. Chemicals in drinking water, of course, would be ingested. They could be inhaled when water is