Chapter 4

PRINCIPAL ELEMENTS OF
A PUBLIC HEALTH RISK ASSESSMENT
FOR CHEMICAL EXPOSURE PROBLEMS

In planning for public health protection from the likely adverse effects from human exposure to chemicals, the first concern usually relates to whether or not the substance in question possesses potentially hazardous and/or toxic properties. As a corollary, once a 'social chemical' has been determined to present a potential health hazard, then the main concern becomes one of the likelihood for, and the degree of human exposure. Ultimately, risk from human exposure to a chemical of concern is determined to be a function of dose or intake and potency of the substance, viz.:

\[
\text{Risk from chemical exposure} = [\text{Dose of chemical}] \times [\text{Chemical potency}] \tag{4.1}
\]

Indeed, both exposure and toxicity information are necessary to fully characterize the potential hazard of a chemical agent – or indeed any other hazardous agent for that matter. This chapter discusses the principal elements and activities necessary for obtaining and integrating the pertinent information that will eventually allow effective public health risk management decisions to be made about chemical exposure problems.

4.1. Characterization of Chemical Exposure Problems

Human exposure to a chemical agent is considered to be an event comprised of the contacting at a boundary between a human body or organ and the chemical-containing medium, at a specific chemical concentration, for a specified time interval. Upon exposure, a receptor generally receives a dose of the chemical – and that may be quite different from the exposed amount; indeed, dose is different from (but occurs as a result of) an exposure (NRC, 1991c). The dose is defined as the amount of the chemical that is absorbed or deposited in the body of an exposed individual over a specified time. A clear understanding of such differences in the exposure parameters is indeed critical to the design of an adequate exposure characterization plan.
The characterization of chemical exposure problems is a process used to establish the presence or absence of chemical hazards, to delineate the nature and degree of the hazards, and to determine possible threats posed by the exposure or hazard situation to human health. The exposure routes (which may consist of inhalation, ingestion, and/or dermal contacts) and duration of exposure (that may be short-term [acute] or long-term [chronic]) will significantly influence the degree of impacts on the affected receptors. The nature and behavior of chemical substances also form a very important basis for evaluating the potential for human exposures to the possible toxic or hazardous constituents of the substance.

While the need for and/or reliance on models and default assumptions is almost always inevitable in most chemical exposure characterization problems, the use of applicable empirical data in exposure assessments is strongly recommended. Information obtained (through monitoring studies) from assessment of direct exposure (e.g., drinking contaminated water) and/or indirect exposure (e.g., accumulation of contaminants via the food chain) should preferably be used. Ideally, the assessment will include monitored levels of the chemical agent in the chemical-containing media, and in human tissues and fluids – and in particular, estimates of the dose at a biologic target tissue(s) where an effect(s) may occur. Such information is necessary to accurately evaluate the potential health risk of exposed populations. Of course, in the absence of complete monitoring information, mathematical exposure assessment models may be employed. These models provide a methodology through which various factors, such as the temporal/spatial distribution of a chemical agent released from a particular source, can be combined to predict levels of human exposures. Still, modeling may not necessarily be viewed as a fully satisfactory substitute for adequate data – but rather as a surrogate to be employed when confronted by compelling needs and inadequate data. Uncertainty associated with these and all methods must be carefully documented and explained to the extent feasible.

4.1.1. FACTORS AFFECTING EXPOSURE CHARACTERIZATION

Several chemical-specific, receptor-specific, and even environmental factors need to be recognized and/or evaluated as an important part of any public health risk management program that is designed to address problems that arise from exposure of the public to various chemical substances. The general types of data and information necessary for the investigation of potential chemical exposure problems relate to the following:

- Identities of the chemicals of concern;
- Concentrations contacted by potential receptors of interest;
- Receptor characteristics;
- Characteristics of the physical and environmental setting that can affect behavior and degree of exposure to the chemicals; and
- Receptor response upon contact with the target chemicals.

In addition, it is necessary to generate information on the chemical intake rates for the specific receptor(s), together with numerous other exposure parameters. Indeed, all parameters that could potentially impact the human health outcomes should be carefully evaluated; this includes the following especially important categories annotated below.