MONITORING AND BIOMONITORING STUDIES FOR OCCUPATIONAL EXPOSURE TO PESTICIDES

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Estimates of exposure levels are fundamental for the assessment and management of human health risks related to occupational and environmental exposure to pesticides. In order to characterize risks, there must be standardized methods to measure exposure. The focus on worker exposure began with physicians and occupational hygienists wanting to understand why industrial workers became overexposed and ill. In the 1950's monitoring programs were aimed to prevent acute illnesses in agricultural workers. In the 1980's the focus switched from preventing acute illnesses to conducting quantitative risk assessments to ensure exposure did not approach the toxicological no-observable effect levels. This led to advances in exposure measurements which can be done by collecting samples from the environment or the worker as well as by determination of the chemical or its metabolites within body tissues.

The most common method of measuring exposure to agricultural workers is by the use of passive dosimetry. Passive dosimetry involves the collection and analysis of clothing worn by the worker as well as wipe or wash samples. Exposure monitoring studies in the 1950's through the 1970's involved the placement of gauze patches in various locations on and under work clothing. In the 1980's the "whole-body" dosimeter method was developed and gradually this has become the standardized method of collecting dermal body residues. Potential inhalation exposure is measured by the use of air-sampling collection devices which are connected to low-volume air-sampling pumps and placed in the breathing zone. Passive dosimetry is used to estimate how much residue a person is exposed to; it does not inform how much has entered the body (absorbed dose). In order to convert dermal exposure to absorbed dose, a dermal absorption value must be used. Passive dosimetry is based on the principles of industrial hygiene monitoring and is non-invasive and relatively easy to administer.

Biological monitoring has the advantage over passive dosimetry in that it provides a measurement of the dose actually absorbed through all possible routes (dermal, inhalation, and oral). This removes the step of using a standard dermal penetration value to estimate absorbed dose. As a result, many consider the use of biological monitoring the best method to determine actual dose of a specific chemical. Biological monitoring of agricultural workers is accomplished by collecting bodily fluids, usually urine. For a pesticide to be successfully measured in urine, a number of criteria must be met. The biomarker must be sensitive and specific – meaning that it should be detectable at trace amounts and must be specific for the pesticide of interest. Additionally, in order to interpret the results, the metabolism and pharmacokinetics must be well understood in primates, preferably humans. As a consequence of these restrictions, biological exposure monitoring can be carried out on a routine basis with only a very limited number of pesticides.

Both passive dosimetry and biological monitoring have their advantages and disadvantages. Although biological monitoring can provide the most accurate measurement of true dose, without accurate excretion and metabolism profiles, the biomarker measurements may be meaningless. Additionally, there are inherent challenges in the study implementation when conducting biological monitoring that must be controlled. To determine which sampling method is most appropriate to use in a study, one must first define the objective of the research. Several other factors should be considered including the population of workers being monitored, the chemistry of the product under investigation, and the estimated exposure using standard models and default assumptions. A thorough evaluation of all these points is needed in order to determine the best sampling methodology for a specific worker exposure study.