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Understanding Risk Assessment

It is often difficult to understand environmental risks. This fact sheet explains how scientists calculate the potential health effects associated with environmental contaminants.

Each day we are exposed to risks. Some risks are the result of our own behavior. Other risks come from factors we don't directly control, including environmental pollutants.

During the past 25 years, scientists have developed methods to assess risk, that is, to estimate or measure the potential harm or unwanted effects that can be expected from exposure to a given activity or chemical agent. This information can help people make informed choices about controlling the risks they face. It is impossible to eliminate all risks from life, but people often can reduce their risks by limiting their exposure to the cause.

Exposure is a key factor in determining risk. We know, for example, that smoking cigarettes increases the risk of respiratory ailments, including lung cancer. People can control these risks by not smoking. Your exposure helps determine your risk; no exposure equals no risk. So in this case, choices can eliminate exposure and reduce risk to nothing.

The role of exposure is important to remember when determining if harmful conditions or exposure to environmental pollutants pose a risk. Not all contaminants released to the environment result in an exposure. Some environmental technologies are designed to prevent exposure. There are three major ways for a person to be exposed to, or come in contact with, an environmental contaminant: skin contact; eating or drinking the substance; and breathing the substance.

Risk Assessments

A risk assessment systematically evaluates the risk posed by an individual's exposure to a particular substance. There are four parts to a human health risk assessment:

- data collection and evaluation
- toxicity assessment;
- exposure assessment; and
- risk characterization.

In simple terms, scientists collect data, look at all the information (data collection and evaluation) and decide whether the substance is hazardous in the amount present to the environment (toxicity assessment). Scientists also determine how people may come in contact with these hazardous substances (exposure assessment). They use this information to calculate the risk of adverse health effects (risk characterization).

Data Collection and Evaluation — Is one or more toxic (harmful) substance present?

The first step in assessing a potential health risk is conducting a site investigation and collecting chemical data from impacted sources (soil, water or air) to determine the presence and amount of potentially harmful agents in the environment.

For an identified source, a large number of samples are collected over a given time period and sent to a laboratory for analysis. The laboratory sends a report that identifies the number and amount of chemical present for every sample. This data is used in the toxicity assessment to identify potential chemicals of concern. Alternatively, computer models can be used to estimate environmental concentrations and exposure pathways. The computer models use well-studied algorithms to mathematically estimate environmental concentrations.

Toxicity Assessment — How toxic is it?

During this step, scientists gather information about the toxic properties of the substances believed to pose a risk.

Toxic properties can come from experiments that study the effect of a substance on animals. In some cases, scientists may study medical records of disease in humans if this information is available. The risk of cancer and other adverse health effects may be evaluated. This step also examines the relationship between the amount of a substance an individual could be exposed to (the dose), and the extent of the negative health effects. The "dose" is the amount of a substance that an individual actually receives. Just as in medicine, the doctor prescribes two teaspoons of cough medicine. That is your dose. The pharmacy may give you a whole bottle, but the dose is the amount you actually consume. The dose is not the amount of the contaminant released to the environment.

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The toxicity assessment calculates how much of a substance is necessary to cause a negative health effect. Scientists calculate the dose that can cause cancer separate from the dose that can cause other health effects.

Many scientists believe any exposure to a cancer-causing substance increases the risk of cancer. Because of this, scientists may assume that there is no completely safe level of exposure to substances known to cause cancer in humans. But scientists can calculate an acceptable dose because some risks are very small when compared to others, or the risks of some exposures are outweighed by the benefits.

For example, a single chest x-ray increases the risk of lung cancer, but the benefits of a chest x-ray in assisting a doctor's care for a sick patient far outweigh the risk. Scientists determine the acceptable dose for humans by finding the acceptable level of exposure for an animal in laboratory experiments.

Acceptable dose levels are calculated to be very conservative and protective of human health. In some risk assessments, an acceptable human dose may be based on the assumption of a constant 24-hour exposure to the particular substance during a 70-year human lifetime. It is estimated that one in three Ohioans born today will develop some type of cancer in his or her lifetime. However, the majority of cancers can be attributed to diet, smoking and heredity.

When calculating health risks other than cancer, Ohio EPA scientists use these assumptions:

- It takes a certain amount of a substance to cause a health effect. This amount is called the "threshold level." Amounts below the threshold level are not likely to cause specific toxic effects.
- Compounds that act similarly can add to each other's health risks.
- If exposure occurs in more than one way (for example, through drinking water and inhalation), the risk is cumulative. The non-cancer risk level of a substance is expressed as a number called a "reference dose." The toxicity assessment is conducted simultaneously with, but independently of, the exposure assessment.

Exposure Assessment — Who is exposed to this stuff, how much, for how long and how often?

This step examines the nature and size of an exposed population, the amount and duration of their exposure, and the "exposure pathway" through which the substance reaches the population.

Risk assessors must sometimes act as detectives, seeking routes through which people may come in contact with a substance. Are people breathing a contaminant because it is in a building ventilation system? Does soil in my back yard carry a contaminant? The risk assessor must consider many possible exposure pathways.

Risk Characterization — So what does this mean?

This final step uses information from the contaminant identification, toxicity assessment and exposure assessment to calculate the estimated human health risk. The risk characterization will show the likelihood that residents or workers near a source will experience any harmful effects.

A risk assessment involves many uncertainties; therefore, the most conservative position is taken to protect human health and the environment. A risk assessment does not give an exact number of people who will be placed at risk by contact with a toxic substance. However, it can show the probability of risk under a given set of circumstances. This information can be used to educate decision makers whose goal is to effectively manage risk.

Many types of expanded versions of human health risk assessments are being developed today. Some scientists are examining indirect exposure pathways, such as the risk of consuming meat from an animal that has accumulated elevated levels of dioxin in its fatty tissue. Sometimes an ecological risk assessment also may be conducted to estimate the potential adverse ecological effects that could result from the release of a hazardous substance or environmental pollutant.

Individuals can use the information from a risk assessment to make informed choices about reducing their exposure. Lawmakers and regulators can use the information to create and administer laws and policies that protect human health and the environment.