HAZARDOUS SUBSTANCE RESEARCH CENTERS

ENVIRONMENTAL SCIENCE AND TECHNOLOGY BRIEFS FOR CITIZENS

Human Health Risk Assessment

by T.K. Boguski

What is risk assessment?

Risk assessment is a method used to estimate people's **increased** risk of health problems as a result of exposure to a toxic pollutant. Risk assessment methods can also be used to estimate increased risk of adverse ecological effects due to toxic pollutants in the environment. There are four steps to risk assessment: hazard identification, exposure assessment, dose-response assessment, and risk characterization.

The Four Steps of Risk Assessment

1. Hazard identification

The first step of risk assessment is hazard identification. This is the attempt to determine what health problems are caused by specific toxic pollutants.

Scientists perform hazard identification by evaluating all available information about the effects of a toxic pollutant. The better the evidence, the more certain scientists can be that a toxic pollutant causes specific health problems. Evidence for humans is often gathered by doing statistical studies on the number of cases of a particular illness or disease occuring in certain groups of people. Human information is very limited for most toxic pollutants. Therefore, scientists often rely on studies done with laboratory animals, such as rats. Results of these studies are used to estimate the effects of a toxic pollutant on humans.

2. Exposure assessment

Exposure assessment is the second step of risk assessment and is used to determine how much of a toxic pollutant people are exposed to and/or how many people are exposed.

Exposure to toxic pollutants occurs through three primary exposure pathways: ingestion, inhalation, and absorption through the skin. Several ways that exposure occurs are listed below.

- Ingestion
  - Eating contaminated soil
  - Drinking contaminated water
- Inhalation
  - Breathing contaminated air
  - Breathing dust that is contaminated with a toxic substance
  - Showering in contaminated water
- Absorption
  - Skin contact with contaminated soil
  - Showering in contaminated water

Exposure is investigated by taking air, water and soil samples and analyzing them in the field or at laboratories. The results indicate the concentrations of toxic pollutants present at a specific location. Exposure pathways are also evaluated. How are the particular pollutants from a particular site reaching people?

Current and future land use are key factors in evaluating exposure pathways. Is the land being used for industrial, commercial, or residential purposes? What are the likely future uses for the land? Is groundwater or surface water being used as a drinking water source? Are contaminants being released into the air in dangerously high concentrations at this site? Are air pollutants accumulating in buildings?

3. Dose-response assessment

The third step of risk assessment is the dose-response assessment. This is the evaluation of the relationship between the amount of exposure to a toxic substance

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The Four Steps of Risk Assessment

1. Hazard Identification

   Is this chemical harmful to humans?

2. Exposure Assessment

   How much of the chemical are people being exposed to over what time period?

3. Dose-response Assessment

   What amount of injury is this level of exposure likely to cause?

4. Risk Characterization

   What is the extra risk to human health caused by this amount of exposure to this chemical?

and the extent of injury or disease caused. In dose-response assessment, the dose is the amount of exposure to the toxic pollutant and the response is the reaction to the toxic pollutant. Dose-response estimates for humans are frequently estimated based on animal studies. When information about dose-response is missing or has substantial gaps, the EPA uses assumptions called default options. These assumptions are conservative in order to protect human health. The following are common default assumptions used in determining cancer risk:

- a chemical that causes cancer in people who are exposed under certain conditions, such as work, is assumed to cause cancer in other people if they become exposed to the chemical;
- a chemical that causes cancer in animals is assumed to be able to cause cancer in people; and
- a high dose of a chemical received over a short period of time is assumed to be equivalent to a low dose spread over a lifetime.
- it is generally assumed that there are no exposures that have "zero risk"—even a very low exposure to a cancer-causing pollutant can increase the risk of cancer; and
- the relationship between dose and response is a straight line—for each unit of increase in exposure (dose), there is an increase in cancer response.

Default assumptions are also made for the amount of exposure to chemicals. For example, in studying drinking water contaminants, the default assumption is that the intake for an adult is 2 liters (about ½ gallon) of drinking water per day for 350 days per year for 30 years.

Collecting health data, doing animal studies, and making assumptions allow scientists to develop dose-response relationships. For cancer, this relationship is often expressed as an increased lifetime risk using expressons such as "one in 10,000."

The dose-response relationship for noncancer effects are calculated differently than for cancer effects. For noncancer effects, a very low dose may not cause harm to human health. Threshold values are developed for noncancer causing chemicals. Doses below the threshold value are considered "safe" and doses above the threshold value are considered harmful.

4. RISK CHARACTERIZATION

Information from the hazard assessment, exposure assessment, and dose-response relationship helps scientists to estimate the extra risk to human health or the environment that is caused by toxic pollutants.

Risk information may be presented in different ways to illustrate how individuals or populations may be affected. Ways that risk may be communicated include the following:

Maximum Individual Lifetime Cancer Risks - an estimate of the increased lifetime risk of cancer for an individual exposed to the maximum predicted long-term concentration.

DISTRIBUTION OF INDIVIDUAL RISKS - THE NUMBER OF PEOPLE ESTIMATED TO BE AT VARIOUS LEVELS OF RISK.

Population Cancer Risks **-** the expected increased incidence of cancer (that is, the number of new cases each year) for all people exposed to the pollutant. For example, the estimated population cancer risk may be the number of new cancer cases per year expected among residents within 30 miles of a certain source of contamination.

How accurate are risk estimates?

Risk estimates cannot be completely accurate because they contain many estimates and assumptions. Scientists often don't have enough information on how toxic substances react in the body or enough information on actual exposure to make completely acurate calculations.

For more information

Risk Assessment for Toxic Air Pollutants: A Citizen's Guide
EPA 450/3-90-024, March 1991
http://www.epa.gov/oar/oaqps/air_risc/3_90_024.html

Superfund Today—Focus on Risk Assessment: Involving the Community
EPA 540-K-98-004 April 1999
http://www.epa.gov/oerrpage/superfund/tools/today/sf_com1.htm

EPA's National Center for Environmental Assessment Internet Web Site
http://www.epa.gov/ncea/

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